



CALIFORNIA  
ENERGY COMMISSION

Arnold Schwarzenegger, Governor

California Energy Commission

# **PUBLIC INTEREST ENERGY RESEARCH**

2008 Annual Report

Investing in California's Future  
Today

March 2009

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# Abstract

The Public Interest Energy Research (PIER) program was created in 1996 when the state Legislature enacted Assembly Bill 1890 (Brulte, Chapter 854, Statutes of 1996), California's electric utility restructuring legislation. This law required that funds be collected annually from the three investor-owned electric utilities and deposited in the Public Interest Energy Research and Development Account, to be invested by the California Energy Commission in public interest energy-related research, development, and demonstration (RD&D). Passage of this law shifted administration of public interest RD&D from California's investor-owned utilities to state government—a major change intended to ensure the continuation of public interest energy RD&D. In 2004 the California Public Utilities Commission designated the Energy Commission as the administrator for a similar research program benefiting natural gas ratepayers. The Energy Commission manages the electricity research program and the natural gas research program through its PIER program. In 2008 the California Energy Commission administered a total of \$83.5 million for research through the PIER program—\$62.5 million for electricity and \$21 million for natural gas RD&D projects.

The Energy Commission's *Public Interest Energy Research (PIER) 2008 Annual Report* is prepared pursuant to Public Resources Code Section 25620.8. This report covers projects funded in the period from January 1, 2008 through December 31, 2008. The Energy Commission's Energy Research and Development Division supported public interest energy research, development, and demonstration for energy efficiency and demand response, renewable energy resources, advanced electricity generation, transmission and distribution, transportation, and energy-related environmental research. This latest annual report highlights recently funded research, completed projects, and current Energy Commission-funded research activities.

## Keywords

California Energy Commission, PIER, energy research, RD&D, energy efficiency, climate science, advanced electricity generation, renewable energy, demand response, T&D, grid, infrastructure, buildings research, distributed generation, smart grid, carbon sequestration, transportation research

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# CHAPTER 1: Introduction

In 2008 the California Energy Commission administered a total of \$83.5 million for research through the Public Interest Energy Research (PIER) program—\$62.5 million for electricity and \$21 million for natural gas research, development, and demonstration (RD&D) projects. Each year the Energy Commission sends to the Legislature a report containing the funding awards made; progress toward achieving research and development portfolio goals; the names of award recipients; the types and actual costs of programs or projects funded; an evaluation of the costs and benefits of selected funded projects; and recommendations for program improvements.

The Energy Commission provides oversight and detailed policy direction for the PIER program through its Research, Development, and Demonstration (RD&D) Committee. The RD&D Committee annually conducts a budget review of the PIER program before the beginning of each fiscal year, examining the status and progress of existing investments, establishing initial target investment levels for the PIER program areas for the coming fiscal year, and ensuring consistency with energy policy priorities. These funding allocations reflect state legislation, the Energy Commission's Integrated Energy Policy Reports (IEPR), interagency collaborative research efforts and executive orders. Throughout the year, the Energy Commission staff carries out program and project development activities within the established budget allocations, using a combination of competitive solicitations, interagency agreements, and sole source contracts to implement the RD&D priorities. The Energy Commission's RD&D Committee reviews and recommends all PIER research projects before approval by the Energy Commission at a public Business Meeting.

This report describes the RD&D activities and accomplishments funded through the Public Interest Research, Development, and Demonstration Fund. Chapter 2 explains how state energy policies and legislative directions drive the PIER program's research investment decisions, compares program research investments made from 1997 through 2007 with research allocation decisions made in 2008, discusses how the research focus is shifting to meet new challenges and opportunities, and highlights collaborative research efforts with other state and federal agencies, research entities, and the private sector. Chapter 3 describes the major PIER-funded research program areas, highlights significant research conducted or initiated by each program research area in 2008, and summarizes planned research. Chapter 4 discusses how PIER research investments benefit California ratepayers and businesses, explains PIER's risk-management strategies, reviews how the PIER Advisory Board will be asked to help guide the program's direction, and discusses how proposed program changes will benefit California businesses competing for research contracts. Finally, an appendix contains the list of 2008 contracts that were summarized in the main report.



## Chapter 2: Investing in Energy Technology Research

Nearly 38 million people live in the Golden State. Keeping California as the preferred place to live, work and play requires a significant amount of energy – electricity to power homes, business and industry; natural gas for generating electricity, heating homes, and firing industrial processes; and fuels for transportation. California’s energy expenditures total nearly \$100 billion each year. Despite California having one of the nation’s most diverse mix of energy resources, more than 80 percent of energy consumed in the state comes from two fossil fuel sources – petroleum and natural gas.

In 1996 the Legislature directed the California Energy Commission to “develop, and help bring to market, energy technologies that provide increased environmental benefits, greater system reliability, and lower system costs, and that provide tangible benefits to electric utility customers...”<sup>1</sup> In 2004 the California Public Utilities Commission designated the Energy Commission as the administrator for a similar research program benefiting natural gas ratepayers.<sup>2</sup>

The Energy Commission manages its electricity research and natural gas research efforts through its Public Investment Energy Research (PIER) program. Senate Bill 1250 (Perata, Chapter 512, Statutes of 2006) extended the authority of the Energy Commission to administer the electricity research funds through 2011. The legislation also clarified the investment categories eligible for PIER funding. The Energy Commission reviews all new awards for consistency with SB 1250.

In 2008 the PIER program received approximately \$62.5 million through surcharges on electricity rates and another \$21 million in surcharges on natural gas rates. (The natural gas surcharges increased to \$24 million in 2009.) Since the program’s beginning the state has invested \$587.7 million to develop, and help bring to market, innovative energy technologies.

### Energy Policies

The state’s energy research investments are driven by energy policy. The state’s energy policy document is the Energy Commission’s Integrated Energy Policy Report (IEPR). This biennial policy report contains an integrated assessment of major energy trends and issues facing the state’s electricity, natural gas, and transportation fuel sectors and provides policy recommendations to conserve resources; protect the environment; ensure reliable, secure, and diverse energy supplies; enhance the state’s economy; and protect public health and safety.<sup>3</sup> The 2007 *Integrated Energy Policy Report* states:

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<sup>1</sup> Public Resource Code section 25620

<sup>2</sup> CPUC Decision 04-08-010

<sup>3</sup> Public Resources Code section 25301(a)

“Since 2003, California’s energy policy has defined a loading order of resource additions to meet the state’s growing electricity needs: first, energy efficiency and demand response; second, renewable energy and distributed generation; and third, clean fossil-fueled sources and infrastructure improvements. This strategy has had the benefit of reducing carbon dioxide emissions and diversifying our sources of energy.”

California’s energy efficiency initiatives, programs and standards have helped the state maintain a flat rate of electricity consumption per capita for the last 30 years.<sup>4</sup> The California Global Warming Solutions Act of 2006 (Nunez and Pavley, Chapter 488, Statutes of 2006) – known as AB 32 – caps California’s greenhouse gas (GHG) emissions at the 1990 level by 2020. Aggressive energy efficiency upgrades, the removal of barriers to the increased use of renewable energy resources and the development of clean electricity generation sources are essential to achieving a lower-cost energy future and will help California achieve the state’s goal of reducing greenhouse gas emissions. As the *2007 Integrated Energy Policy Report* notes: “California’s ability to slow the rate of growth of greenhouse gas emissions will largely depend on the success of its energy efficiency and renewable energy programs and its commitment to clean air and clean energy.”<sup>5</sup> The report also cautions, however, that “California must determine how to meet its renewables and greenhouse gas emission reduction goals while minimizing the costs and risks borne by ratepayers for electricity generation.”<sup>6</sup> Energy Commission RD&D provides new technologies, tools, standards and protocols to help advance these energy policies.

### ***A Decade of High-Priority Energy Research***

During 2008, the Energy Commission’s Research, Development, and Demonstration Committee began a new strategic planning cycle for the PIER program. As part of that process, the PIER program staff reviewed the PIER investments made from 1997 through 2007 for consistency and responsiveness to the state’s policy direction. The review affirmed that the Energy Commission’s total RD&D budget has been allocated in accordance with the state’s energy priorities, as graphically displayed in Figure 1.

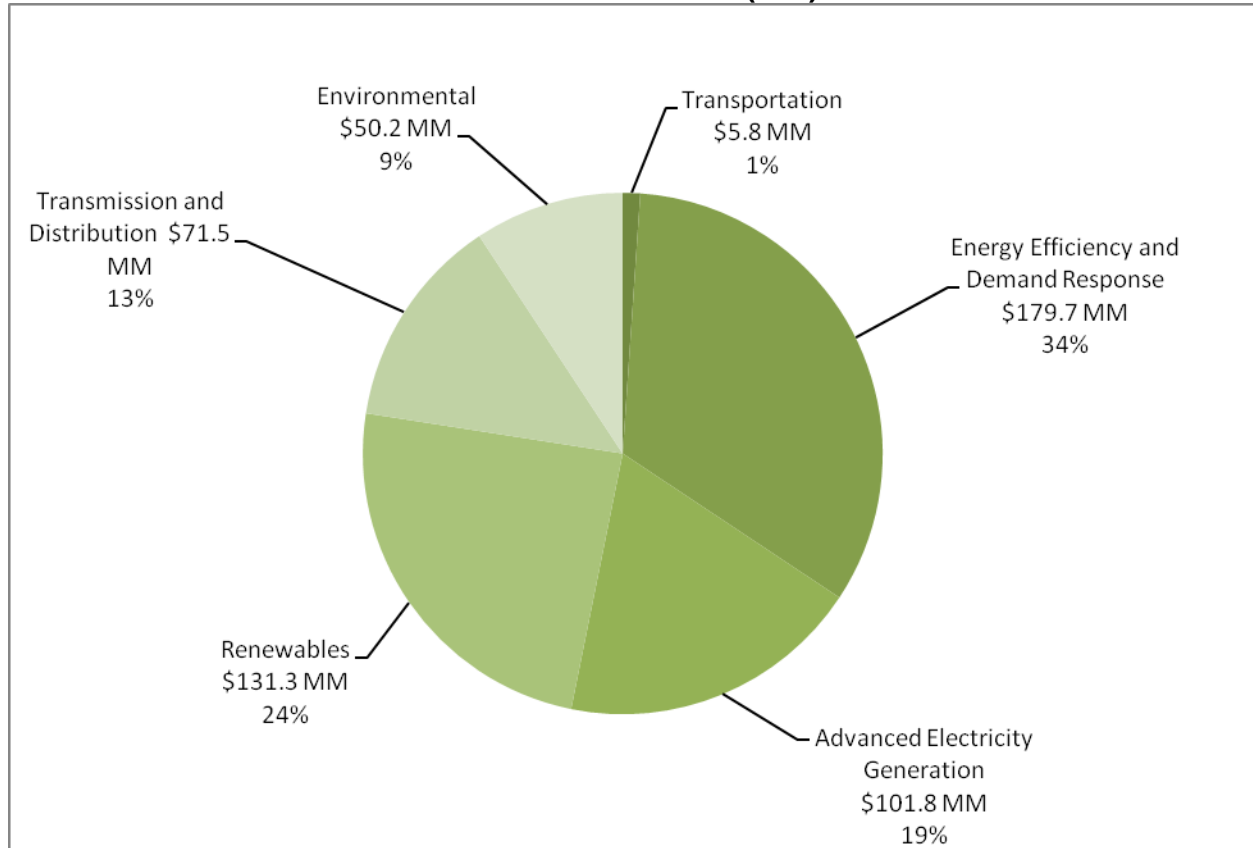
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<sup>4</sup> 2007 *Integrated Energy Policy Report*, p. 2

<sup>5</sup> 2007 *Integrated Energy Policy Report*, pg. 19

<sup>6</sup> 2007 *Integrated Energy Policy Report*, p. 101

**Figure 1: PIER Research Investments by Research Program Area (1997-2007)**  
**Total \$540.3 Million (MM)**



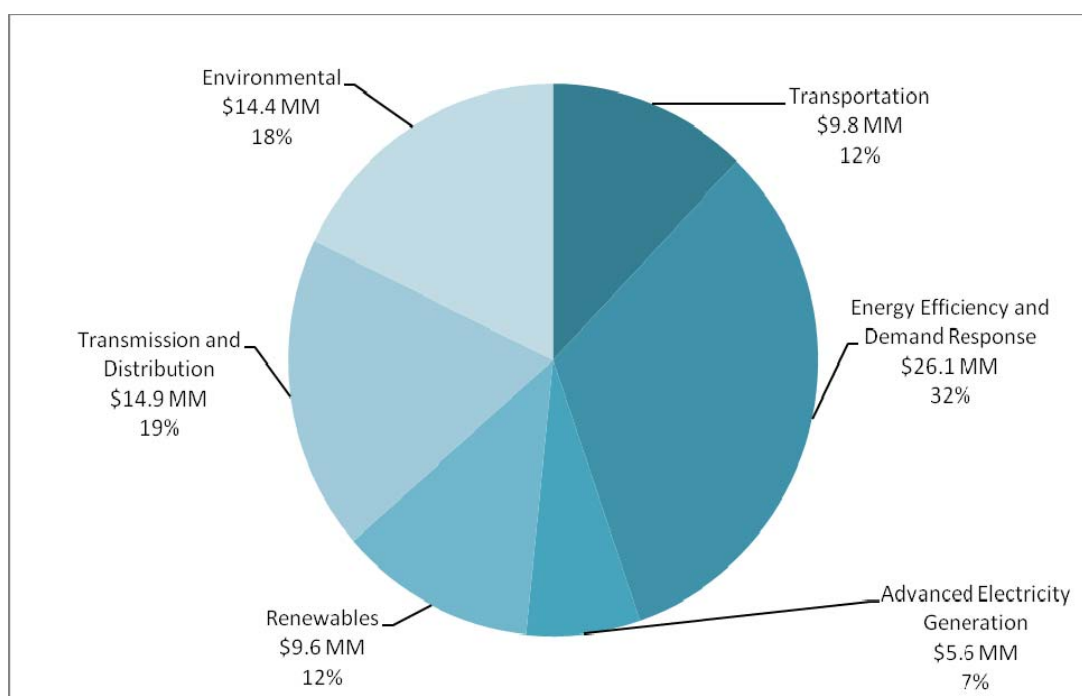
During the 10-year period, the first energy priority of efficiency and demand response was allocated the lion's share – \$179.7 million (34 percent of total funding) – of the PIER research budget. The share for renewables research – the second priority – was \$131.3 million (24 percent). The advanced electricity generation research share was \$101.8 million (19 percent). Transmission and distribution research received \$71.5 million (13 percent). Energy-related environmental research totaled \$50.2 million (9 percent). Energy-related transportation research, which began receiving PIER funding in 2006, received \$5.8 million (one percent) of PIER funding. This funding was used for research improving motor vehicles' energy efficiency and adapting transportation technologies to use renewable fuel sources – consistent with the state's two highest energy policy priorities for energy efficiency research and renewables research.

## ***Response to Current Energy Policy***

The 2007 IEPR emphasizes the need to remove barriers to the increased use of renewable resources for the state's energy needs. In addition to reducing dependence on fossil fuels and protecting against natural gas price increases, the increased use of renewables will help achieve the state's aggressive greenhouse gas emission reduction goals. Concurrent with the need to increase the use of renewables, the state encourages the development of clean fossil-fueled power plants and the modernization of the transmission and distribution system infrastructure needed to carry power generated by renewable and distributed resources. Following policy direction provided by the 2007 IEPR, the Energy Commission's research funding priorities in 2008 ensured stronger integration of its efficiency, renewable, advanced electricity generation and infrastructure RD&D. The Energy Commission's energy-related environmental research now also addresses California's climate adaptation needs.

For 2008, the RD&D Committee allocated a total of \$62.5 million in electricity research funds and \$17.85 million in natural gas funds to the six PIER research program areas (see Figure 2).

**Figure 2: 2008 PIER Research Budget Allocations by Research Program Area  
Total \$80.4 million (MM)**



The 2008 allocations largely mirror the 10-year historical averages. When making allocations among the PIER research program areas, the RD&D Committee considered the state's priority loading order for resource additions; the 2007 IEPR recommendations for increased research in renewables, transmission and distribution infrastructure, climate adaptation, and advanced transportation technologies; the programmatic research needs identified as priorities by the

PIER research program managers; opportunities to partner with other research organizations and leverage PIER research funds; unexpected or time-critical targets of opportunity; and other research needs that should be addressed by the PIER program.

The advanced transportation research program received a significant funding increase, as the CPUC authorized an additional \$3 million for natural gas research for 2008. Reflecting the need to enhance the reliability and stability of the state's electricity grid, the transmission and distribution infrastructure research program's allocation increased to \$14.9 million (19 percent of available funding compared to the 10-year historical average of 13 percent). Consistent with legislative direction and state energy policy to increase energy-related climate change research, the environmental research program's allocation increased to 18 percent of available funding compared to the historical average of 9 percent.

The energy efficiency and demand response research program was allocated \$26.1 million in 2008 funds (32 percent of available funding). The renewables research program was allocated \$9.6 million (12 percent). The advanced electricity generation research program has \$5.6 million (7 percent). The environmental research program was allocated \$14.4 million (18 percent). The energy-related transportation research program was allocated \$9.8 million (12 percent). The RD&D Committee authorized the Energy Commission staff to develop individual research projects using these 2008 budget allocations for the PIER program.

The PIER program has a two-year period to encumber funds allocated by the Legislature. Consequently, a portion of the allocated funds shown in Figure 2 will not be encumbered for specific research projects until 2009. Similarly, some funding encumbered in 2008 to initiate new research projects was originally allocated in 2007. Chapter 3 identifies the funds encumbered in 2008 for each of the PIER research program areas. For example, the PIER renewables research program, although allocated \$9.6 million in 2008 funds, actually encumbered \$20.3 million for renewables research projects, using a combination of 2007 and 2008 funding.

## PIER Investment Strategies

The Energy Commission uses multiple investment avenues to implement the strategic research and development vision embodied in legislative direction and state energy policy — *further energy policy goals through strategic investments in research and development*. To identify and select the research projects that best reflect the state's energy priorities of 1) achieving all economic energy efficiency improvements, 2) increasing the use of renewable resources, 3) developing clean new technologies and improving the energy infrastructure, and 4) ensuring that energy research helps achieve California's greenhouse gases (GHG) reduction goals, the Energy Commission's PIER program employs these investment approaches:

- ***Research Roadmaps*** - identify technology gaps and cutting-edge research opportunities.
- ***Competitive Solicitations and Small Grants*** - ensure that promising new technologies are developed and demonstrated.

- ***Achieve Economies of Scale*** - use community-scale research opportunities with multiple technologies and participants to achieve what individual projects alone cannot.
- ***Integrate Energy and Land Use*** - ensure that state land use policies reflect the impact of land use decisions on energy systems, including renewable resources, electricity generation, transmission corridors and transportation.
- ***Targets of Opportunity*** - work with individual companies on specific applications, such as testing new technologies on the California electricity grid; leverage other current research, such as enhancing “green buildings” initiatives; and respond to unexpected opportunities, such as the new federal economic stimulus package.
- ***Engage the Research Community*** - focus California’s world-class scientists and engineers at its universities, national laboratories, and industries on the state’s energy priorities, including support for new and existing collaborative campus-based energy technology research centers.

## ***Research Roadmaps***

The Energy Commission fully recognizes and appreciates the role that stakeholders play in identifying research opportunities. Every PIER-funded research area includes a research roadmap developed in consultation with business and industry, the environmental community, the private sector, the academic research community, and other parties interested in energy-related research. Stakeholders and the public are invited to develop a shared vision through workshops and written comments. Domestic and international literature is reviewed for relevant and current information on the topic, and experts are interviewed and consulted.

These roadmaps help identify knowledge gaps, technology issues or problems that should be addressed through PIER research investments. Roadmaps are developed in consultation with stakeholders to ensure that PIER research addresses defined needs and does not duplicate research already funded by the private sector or other research entities. A roadmap also allows a sequential, incremental approach that uses limited research funds in a fiscally prudent manner.

## ***Competitive Solicitations and Small Grants***

The Energy Commission funds most new research projects through programmatic competitive solicitations, consolidating a number of related research issues into a single solicitation. These competitive solicitations stimulate a variety of proposals to meet the state’s research needs, provide a low-cost bid competition and maximize staff efficiency in managing contracts. Competitive programmatic solicitations released in 2008 include the following:

- \$16 million for technology innovations for buildings and communities.
- \$2 million for buildings efficiency applied research.



- \$1 million for waste heat recovery from industrial processes in California.
- \$2 million for energy efficiency in California's food processing and dairy processing industries.
- \$9.1 million for renewable-based energy secure communities.
- \$2 million for adapting advanced mobile combustion engine technology to stationary engines.
- \$3.8 million for combined heat and power (CHP) and combined cooling, heating, and power (CCHP) systems research.
- \$2.9 million for impacts of climate change in California.
- \$4.25 million for energy-related environmental research.

Two of the Energy Commission's RD&D programmatic offerings are specifically designed for higher risk, "proof-of-concept" ideas. The Energy Innovation Small Grants (EISG) program and the Buildings Energy Research Grant (BERG) program are two programs in which the Energy Commission explicitly tracks – and expects – a number of technical failures. As a "proof-of-concept" program, each program seeks out concepts that are not yet proven and are very early in the research pipeline. These programs encourage technical innovation and risk taking. In each program, the Energy Commission awards small amounts of funding – up to a maximum of \$95 thousand for the EISG grants and a maximum of \$300 thousand for the BERG grants – to test a new idea. After project completion, the PIER program uses independent experts to evaluate the research results and assess the technical success compared to the original project objectives, and the likelihood the product will succeed in the market.

Often, the results are not black and white. Typically, some things work as planned, but lessons learned in the process demonstrate that a tune-up in the research will produce a better product. Energy Commission staff works with the researcher to develop a revised product plan, so a project with a revised test plan is not a "failure," even though not all initial metrics were met. Built-in management mechanisms help guide projects to a successful conclusion.

The Energy Commission uses technical advisory committees to provide both technical critiques as well as stakeholder input to improve both the focus of research and the market acceptability of the developed products. For example, the PIER buildings efficiency program uses a 10-member technical advisory committee for its \$2.5 million "Lighting California's Future" program. The advisory committee, which meets quarterly, provides technical critiques for research projects developed by PIER staff in daylighting, lighting-based demand response, classroom lighting, lighting controls and solid state lighting. These critiques help focus PIER research on the most critical technology issues and provide timely feedback on PIER research that is used for mid-course corrections.

Research is not always about developing new “widgets.” Research also can acquire and provide new information; identify new processes that reduce cost, improve performance, and overcome technical obstacles; advance new theories; and confirm hypotheses. Research can also produce findings that are contrary to initial assumptions, allowing future efforts that explore alternatives which might otherwise have been ignored. This process is challenging to measure, but is significant nonetheless. The Energy Commission uses expert reviews to measure – both quantitatively and qualitatively – whether the research investments are optimal and well managed.

RD&D encompasses taking a concept from the basic research phase to eventual commercialization. The process involves a great many investment steps along the way, often takes many years and is inherently risky, as the outcome is not guaranteed. The Energy Commission has developed a phased approach to help mitigate the inherent risks of research. By implementing a phased approach to research, results are evaluated at each stage, and the risks and benefits are assessed before committing to the next stage. The Energy Commission has developed the following research stages:

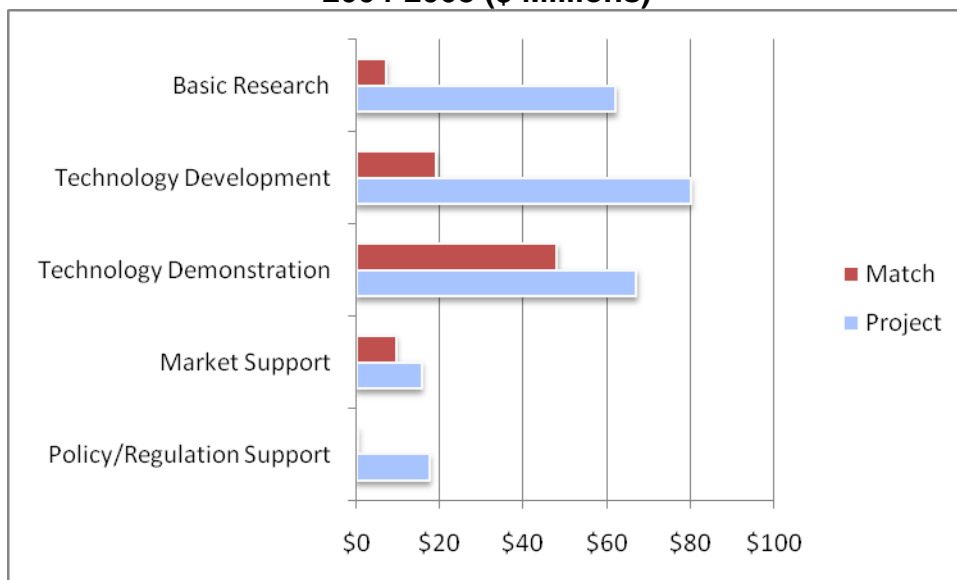
- *Basic Research:* A preliminary study undertaken to ascertain the likelihood of the project success. Basic research provides information at the highest-risk end of the research continuum. Often, PIER takes the first step when there is a lack of market investors willing to explore the feasibility of new energy technologies or products. PIER research fills the niche when market research doesn’t respond to public policy needs.
- *Technology Development:* Research that seeks to gain knowledge or understanding necessary to determine how a recognized need may be met, including needs to achieve specific commercial objectives with respect to products, processes or services.
- *Technology Demonstration:* Demonstrations help bridge the gap between research and market phase by constructing and demonstrating the viability of a new product, process or service.
- *Market Support:* The technology transfer process of taking a new product from development to commercialization, including production launch and ramp-up, marketing materials and program development, supply chain development, sales channel development, training development, training, service and support development.
- *Policy and Regulation Support:* Research that informs decision makers and provides a factual basis for the development of policy, regulation and legislation.

PIER funding can be very helpful in the basic research stage when project proponents face difficulties in securing outside investors for investigating a theory or a premise. Similarly, in the technology development and technology demonstration stages, the need for PIER funding increases. As a product moves closer to commercialization and a working prototype is necessary, however, the project proponent’s ability to attract outside investors increases as the potential profitability of a product is realized. In the market support stage, the PIER funding

needs decrease further as the product is taken from the development stage to the market. PIER funding at this stage helps by implementing all of the services and promotion necessary to inform the public and make the product available and profitable for potential investors.

The policy and regulation support stage is a separate stage from the commercialization process. In this post-commercialization stage, PIER research may, through demand pull, help an energy-saving product or a preferred energy generating technology to secure a place in the market through regulation. Over the past five years, PIER funding has been distributed consistent with this model. From 2004 to 2008, PIER invested \$62 million in the basic research stage, \$80 million in the technology development stage, \$67 million in the technology demonstration stage, and \$16 million in the market support stage. PIER invested \$17 million in the policy and regulation support stage. Figure 3 illustrates the 2004-2008 distribution of PIER funding in relation to partner match-funding across research stages. The graphic illustrates the highest percentage of leveraged funding in the technology demonstration phase and the market support phase.

**Figure 3: PIER Projects and PIER Partner Match-Funding  
2004-2008 (\$ Millions)**



As directed by SB 1250, the Energy Commission has increased its focus on bringing products to market, which involves a greater emphasis and coordination with venture capitalists, utility programs, manufacturers, and others. As research products get closer to commercialization, the Energy Commission seeks to decrease its funding and increase funding from others by handing off promising products to venture capitalists and other entities, such as the Emerging Technologies programs run by California utilities. These utility programs offer incentives to consumers to assist in getting new products to the market place.

## ***Achieve Economies of Scale***

One opportunity to achieve greater statewide energy efficiency is to include in the portfolio of future PIER projects some that concentrate on entire communities, rather than just individual homes or businesses. For example, while a few individual buildings with ideal orientations and access to sunlight may be able to offset their own electricity consumption through photovoltaics, a community-wide approach could integrate numerous energy generation, renewable, energy efficiency and demand response technologies. The Energy Commission also has structured several research projects to incorporate an array of related technologies rather than just a single technology. This synergistic research effort is reflected in the PIER program's 2008 Renewable Energy Secure Communities program opportunity notice, which elicited 51 proposals from communities and other qualified organizations.

## ***Integrate Energy and Land Use***

The body of research on the impact of land use on energy and climate is receiving significantly more attention with the growing world-wide interest in climate change. The 2007 *Integrated Energy Policy Report* concludes:

“Land use impacts on energy demand, energy generation, and transmission and on greenhouse gas emissions are in the early stages of exploration. Further research and development is necessary to explain and quantify the effect land use has on energy systems. Research is needed to develop and update existing modeling and decision-support tools to improve the integration of energy considerations into future planning and development efforts.”

Consistent with this policy direction, the Energy Commission is dedicating additional resources to studying opportunities and barriers to integrated energy and land use planning. For example, in 2008 the PIER environmental research program developed a model, in partnership with Southern California Edison, to help analyze and communicate complicated energy facility siting decisions to policy makers and various stakeholders. The model, known as the Planning Alternative Corridors for Transmission (PACT) tool, processes environmental and engineering information relevant for proposed energy developments, such as transmission line corridors, to ensure the projects comply with California's Environmental Quality Act. The model allows utility and regulatory planners to conduct an analysis, and all stakeholders to view, investigate, understand, and use the analysis.

In addition, the Energy Commission has expanded the residential buildings efficiency research program to include research opportunities known as “Green Building” initiatives. These research projects will advance environmentally-friendly technologies that satisfy the state's goal of using energy efficiency to reduce the need for more energy generation.

## ***Engage the Research Community***

In 2008 the Energy Commission continued its successful research partnerships with the University of California and other academic research institutions. In addition to working closely with the federal Department of Energy's National Laboratories, the PIER program initiated research at the Western Cooling Efficiency Center, the California Lighting Technology Center, the Plug-in Hybrid Electric Vehicle Research Center and the California Climate Change Center.

The PIER buildings efficiency research program is working with the Western Cooling Efficiency Center, located at University of California, Davis (UC Davis), to accelerate the adoption of regionally appropriate cooling technologies for new and existing low-rise, nonresidential buildings (such as suburban retail and office buildings). It is a voluntary program that will require industry to meet performance specifications for new rooftop air conditioning units. The research targets California and other western states that have dry summer climates. The program specifically aims at reducing peak demand, one of the greatest challenges facing California utilities.

The California Lighting Technology Center, located at UC Davis, received national recognition in 2008 for an Energy Commission-funded buildings research project that developed an energy-efficient direct/indirect desk lamp that uses on-board dimming and occupancy-sensor technology for task and ambient lighting in the small office and home office market.

The PIER transportation research program collaborated with the Plug-in Hybrid Electric Vehicle Research Center at UC Davis to develop the PIER roadmap for plug-in hybrid electric vehicle research. In partnership with the National Renewable Energy Laboratory, the PIER transportation research program re-established the Natural Gas Vehicle Technology Forum with members from gas utilities, manufacturers, non-governmental organizations, and end users. The forum brings together stakeholders from all segments of the natural gas vehicle market to share insights to the barriers they have encountered and to identify research that can overcome these barriers.

The Energy Commission works closely with the California Climate Change Center, a virtual research institution based at several universities throughout the state (e.g., Scripps Institution of Oceanography, Stanford, University of California (UC) Berkeley, UC Santa Barbara, and UC Santa Cruz) and national laboratories. Information gained from the Climate Science research area was instrumental in the California Climate Action Team's policy discussions and to the Natural Resource Agency's development of a Climate Change Adaptation Plan, which extensively uses the results of 40 studies on climate change impacts and adaptation strategies commissioned by PIER.

In addition to academic institutions, the Energy Commission's PIER program collaborates closely with the state's major investor-owned utilities and publicly-owned utilities. A key research forum is the Emerging Technologies Coordinating Council (ETCC), which functions under the aegis of the California Public Utilities Commission. The ETCC provides a utility

bridge into the commercial market place for energy technologies developed through PIER funding. As one example, the Energy Commission collaborated with the Southern California Edison Company to develop a screening tool and reference guide to improve the efficiency of pumps at wastewater treatment facilities. This screening tool and reference guide provide utility account representatives with the resources to conduct a knowledgeable interview with wastewater treatment facility personnel, prioritize facilities according to potential energy savings, and identify specific measures to improve pump-system efficiency.

The Energy Commission also co-sponsored the 2008 Utility Energy Forum, a statewide conference of utility program managers, energy researchers, and state and federal energy agencies. The conference provides a forum for mid-level staffs that develop and implement customer programs related to energy efficiency, renewable energy, and demand response in energy utilities serving California and neighboring states.

## **2008 Research Initiatives**

The Energy Commission began new initiatives in 2008 that further the state's energy goals to reduce future energy demand through energy efficiency and to increase the use of renewable resources. Another new initiative involves transmission and distribution research projects that will help create a first-in-the-world "smart grid" system for California. An advanced electricity generation research initiative, involving collaboration with a regional coalition of western states, will use a \$65.6 million grant from the U.S. Department of Energy to capture a power plant's carbon dioxide emissions and store it underground. The PIER program will also continue to coordinate its research activities in collaboration with numerous state and federal agencies, as well as manufacturers, trade associations, non-governmental entities, utilities and academic research centers.

### ***Smart Grid***

A key research goal is to improve the transmission and distribution infrastructure to carry the additional electricity generated from renewable energy resources. To meet this goal, the PIER program funds transmission and distribution research projects that will help create a California "smart grid" system with the ability to integrate more renewable energy resources, support the increasing use of renewable energy by all customers, and provide new and innovative options to meet California's energy needs. Working in collaboration with California's utilities, the PIER program has initiated research projects to evaluate the use of smart grids to expand the capacity and improve the operational reliability of the transmission and distribution system.

By integrating telecommunications, electricity generation and efficiency resources, smart grid technologies can assist the state in meeting numerous energy policy goals. Electricity transmission and distribution will become more reliable, as grid operators develop the tools to better monitor, isolate, and correct problems in the grid. Consumers and utilities will be able to work together to reduce peak electricity demands and share cost savings. Smart grid technology can assist a tariff program that would provide incentives for electric vehicles to

charge overnight and return electricity to the grid during peak times. In addition to providing electricity for meeting peak electricity demands, such a tariff program also could encourage customers to switch from conventional gasoline vehicles to full- or hybrid-electric vehicles, reducing California's dependence on greenhouse gas-intensive transportation fuels.

This research will provide essential input to the Energy Commission's load management standards proceeding, and the Smart Grid rulemaking opened by the CPUC in December 2008.<sup>7</sup> The research includes natural gas research funds because California's electricity generation industry is a major user of natural gas. Improving the efficiency and reliability of the electrical grid reduces the need for "peak load" generation, which relies almost exclusively on natural gas-fired power plants.

### ***Carbon Sequestration (WESTCARB)***

The Energy Commission collaborates extensively with, and leverages major funding from, the federal Department of Energy (DOE) and other states, particularly those in the western region of the United States that are critical partners in California's quest to ensure an adequate, reliable and environmentally-acceptable supply of energy resources. Established in 2003, the West Coast Regional Carbon Sequestration Partnership (WESTCARB) is one of seven regional research partnerships throughout the United States to explore opportunities to capture carbon dioxide from the atmosphere and store it securely underground. In 2008 the U.S. DOE awarded a competitive grant to the Energy Commission for \$65.6 million to co-fund Phase III of the WESTCARB research project.

Phase III is a 10-year project to conduct a commercial-scale carbon capture and sequestration demonstration within California to validate the feasibility, safety, and efficacy of storage in deep geologic formations. The geologic sequestration pilot project of WESTCARB Phase III will be coupled to a natural gas-fired power plant and will provide a critical greenhouse gases reduction technology portfolio element by demonstrating, for the first time, a zero-emissions natural gas power technology that will be deployed just prior to commercialization. To maintain a reliable electricity supply at reasonable cost requires that viable clean energy technologies are expeditiously developed and proven so that they are available to the state's power providers in this time frame.

This research supports energy priority goals to develop "clean" electricity generation, SB 1250 goals to advance technologies that reduce greenhouse gas emissions, and AB 1925 requirements to recommend how the state can develop parameters to accelerate the adoption of cost-effective geologic sequestration strategies for the long-term management of industrial carbon dioxide.

### ***Collaborations and Interagency Agreements***

The Energy Commission collaborates with other state agencies, federal agencies, the national research laboratories, other research organizations, and environmental organizations to identify

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<sup>7</sup> CPUC Proceeding R.08-12-009

and evaluate potential research projects, ensure PIER research complements and extends other parties' research, and leverage PIER research funding with funding provided by other research partners. For example, research into the impacts of energy-related climate change on California is important to help decision makers formulate coherent policies. The Energy Commission coordinates its energy-related climate science research projects – including climate modeling and monitoring, greenhouse gas emissions reduction, and climate change impacts and adaptation – with more than a dozen other state agencies, departments, and commissions to identify new research areas and opportunities, ensure consistency and avoid duplication. These state agencies, commissions, and departments formed the Climate Action Team (CAT) Research Subgroup to ensure coordination among state departments; identify research gaps and opportunities for collaboration; and provide a forum for discussing future state climate change research priorities in California. The Research Subgroup is chaired by Commissioner James D. Boyd, Vice-Chair of the California Energy Commission and a member of the Energy Commission's RD&D Committee.

In 2008 the PIER renewables research program began structuring a collaborative research agreement with the California Renewable Energy Collaborative, an umbrella organization for the California Biomass Collaborative, the California Wind Energy Collaborative, the California Geothermal Collaborative and the California Solar Collaborative. These organizations serve as a venue for technical information exchange and coordination among industry, government, utility, and academic research stakeholders, and, in addition, conduct early-stage research that feeds forward to PIER renewable RD&D projects. The agreement is expected to be executed in 2009.

In collaboration with the Water Research Foundation, the PIER energy efficiency research program developed a benchmarking tool for wastewater treatment facilities. The tool was adopted by the U.S. Environmental Protection Agency and incorporated into the Energy Star Management Portfolio. More than 100 wastewater facilities have used the benchmarking tool to reduce energy use and reduce operating costs.

The PIER advanced electricity generation research program participated in the California Stationary Fuel Cell Collaborative (CaSFFC), which is a public-private partnership working to advance the deployment of stationary fuel cells for distributed generation throughout the state of California. The CaSFFC helped in the preparation of draft RD&D roadmaps for fuel cell and distributed generation research.

In determining research opportunities, the Energy Commission continues to work closely with other state agencies that have energy-related responsibilities. The PIER buildings research program staff collaborated with the Department of General Services (DGS) to provide research information needed to help DGS meet the goals of Executive Order S-20-04 to improve the energy efficiency of state buildings. The staff also provided DGS with research information that led to DGS including building commissioning as a "business as usual" practice in its internal project management procedures.



In 2008 the PIER demand response program staff continued demonstrations of demand response to support California Independent System Operator (California ISO) grid energy management. During the summer of 2008, PIER program research was used to demonstrate how demand response can support California ISO ancillary services, such as spinning reserves, by completing demonstrations involving more than 1,200 customer sites whose air-conditioning system loads were briefly reduced during times of peak energy demand. Based, in part, on the results of the Energy Commission-funded research, the CPUC ordered California's investor-owned utilities to implement Participating Load Pilot programs that will participate formally in the California ISO's new Market Redesign and Technology Upgrade program, beginning in the summer of 2009.



## Chapter 3: Research, Development and Demonstration Investments and Project Results in 2008

The Energy Commission, when making research investment decisions, takes a portfolio approach to RD&D. This approach provides tangible energy and environmental benefits to the state's electricity and natural gas customers, increases diversity and reduces risks when developing new solutions to California's energy challenges, spans near-term, mid-term, and long-term planning horizons, and manages risks and rewards of RD&D investments by taking a holistic and integrated approach.

SB 1250 requires the Energy Commission to conduct research that provides tangible benefits to electricity and natural gas ratepayers through investments in the following technical areas:

- *Advanced transportation technologies* that reduce air pollution and greenhouse gas emissions beyond applicable standards.
- *Increased energy efficiency* in buildings, appliances, lighting, and other applications beyond applicable standards.
- *Advanced electricity generation technologies* that exceed applicable standards to increase reductions in greenhouse gas emissions from electricity generation.
- *Advanced electricity technologies* that reduce or eliminate consumption of water or other finite resources, increase use of renewable energy resources, or improve transmission or distribution of electricity generated from renewable energy resources.

To focus its research policy implementation efforts, the PIER technology research program portfolio is divided into the following major research areas:

- Energy efficiency and demand response
- Renewable resources
- Advanced electricity generation
- Transmission and distribution infrastructure
- Energy-related Environmental Research
- Advanced transportation technologies

The following discussions explain each area's place in the energy research portfolio, describe its research objectives, highlight examples of projects completed or initiated during 2008, and identify planned research. The areas are listed and discussed using the loading order priority established through state energy policy. Although advanced transportation technologies research is not explicitly included in the loading order, the *2007 Integrated Energy Policy Report* recognizes that transportation-related research satisfies the state energy policy's highest priorities by focusing on the pursuit of maximum achievable energy efficiency and the adaptation of cars and trucks to use renewable fuels.

## Energy Efficiency and Demand Response

Energy efficiency and demand response research has been a mainstay of the PIER program from its inception. SB 1250 and AB 32 reinforced the importance of new energy efficiency and demand response research by establishing a new emphasis on market penetration of technologies. The PIER energy efficiency and demand response program initiated \$5.6 million of PIER research funding in 2008.

### ***Energy Efficiency***

The Energy Commission is investing in new technologies, tools, and methods to further boost the cost effectiveness of energy efficiency products by supporting an integrated portfolio of research projects that addresses energy efficiency and demand response needs in the commercial, residential, industrial, agricultural, and water supply sectors.

In 2008 Energy Commission energy efficiency research followed the new directions in SB 1250 and new urgency for action reflected in AB 32 by shifting the energy efficiency research portfolio emphasis toward efforts that lead to more near-term market results. Allocations for the 2008 PIER budget reflect this emphasis for energy-efficiency research and commit PIER to bridging the gap that exists between a newly developed technology and its market deployment and acceptance.

The following examples represent research projects completed by the PIER energy efficiency research program in 2008:

- **Advanced, highly-efficient reverse-annulus, single-ended radiant tube (RASERT) for industrial boilers.** Twelve RASERTs based on the prototype design were deployed in a steel galvanizing line operated by California Steel Industries. Following the retrofit, a comparison of RASERT performance with the baseline performance of burners in the retrofitted zone showed that the new burners produced a 25 percent improvement in thermal efficiency. Emissions of oxides of nitrogen (NO<sub>x</sub>) were reduced by approximately 55 percent; emissions of carbon monoxide, 58 percent; and emissions of carbon dioxide, 25 percent. The retrofit will also save an estimated 2 million cubic feet of natural gas per year.
- **Smart bi-level outdoor lighting.** The PIER buildings research program developed an innovative lighting system that uses motion-sensor technology to save 50 percent of the energy used in traditional outdoor lights.
- **Testing protocol for high-performance window and building façade systems.** Window and building façade systems have very large impacts on all aspects of commercial building performance. They directly influence peak heating and cooling loads, and indirectly influence lighting loads when daylighting is considered. In addition to being a major determinant of annual energy use, they can have significant impacts on peak cooling system sizing, electric load shape, and peak electric demand. Because they are prominent architectural and design elements and because they influence occupant preference, satisfaction and comfort, the design optimization challenge is more complex than with

- **Parabolic trough solar system.** The PIER program funded a demonstration project that delivered process heat to a commercial food processing facility, displacing about 19 billion Btu/year of natural gas currently used to heat water and generate steam and reducing the facility's natural gas use by 30 percent per year.
- **Benchmarking tool for wastewater treatment facilities.** The PIER-funded benchmarking tool was adopted by the US Environmental Protection Agency and incorporated into the Energy Star Management Portfolio. More than 100 wastewater facilities have used the benchmarking tool to reduce energy use and reduce operating costs.

Future research is to improve the energy performance for new and existing buildings; promote the development of new technologies and building strategies to advance building and appliance codes and standards; improve energy efficient building construction and operating practices through science and technology advancements; demonstrate emerging industrial technologies; and explore opportunities to improve energy-related technologies used in water reuse and recycling. The PIER energy efficiency program also will recommend funding Emerging Technology Demonstration Grants that will demonstrate emerging industrial technologies that are past the proof-of-concept stage but not quite ready for commercial production.

## ***Demand Response***

California's electricity grid is stressed from continuing growth in peak electricity demand. "Demand response" tools—using technologies that notify customers when energy prices are high or when there is a system emergency so that they can elect to reduce load—are emerging as a powerful consumer-oriented means to reduce the need to construct traditional fossil-fueled power plants; help grid managers avoid electricity outages; and reduce reliance on existing polluting, expensive fossil-fuel peaking units.

In 2008 the PIER demand response research program focused on two areas: first, expanding ongoing research to provide California rate payers with options to participate in demand response programs and tariffs, and, second, demonstrating new methods for using demand response to the California ISO management.

The following examples illustrate demand response activities funded in 2008:

- **Using Demand Response to Supply Spinning Reserves.** Conducted the first-ever field demonstration using demand response technologies to supply spinning reserves as an ancillary service for the grid.

- **Automated Demand Response.** Drafted, coordinated, and published a new open industry specification for the automation of demand response. This specification, which is an open information model, represents a critical step in institutionalizing demand response in California. The model provides customers, utilities and manufacturers the information needed to automate their demand response efforts and will provide California more low-cost demand response assets in the future and reduce the need for new “peaker plants” that are only called upon during times of very high-peak loads. More than 200 facilities in California now use this automation system, which provides of 55 Megawatts (MW) of demand response.
- **Removing Barriers to Dimmable Ballasts.** Initiated a project addressing several technical and implementation issues that are barriers for using dimmable ballasts as a demand response option for commercial buildings. Lighting consumes up to 37 percent of the energy used by California's commercial sector. The majority of commercial buildings in the state are unable to vary the amount of energy their lighting systems require. During peak demand times, a significant amount of energy would be conserved if commercial lighting had the capacity to dim or be controlled.

Future research includes negotiating and executing agreements to implement new state building and appliance standards for automated demand response technologies; integrating new demand response services into the advanced meters and home area network systems being field tested in California; working with manufacturers and industry representatives to assist them in making their systems compatible with grid-reliability applications when manufactured products come off the production line; expanding the field demonstrations of using demand response as a grid ancillary resource; researching new methods to improve dynamic rates and tariffs; and providing technical support to the California ISO's new Market Redesign Technology Upgrade effort that becomes operational in 2009.

## Renewable Resources

Renewable resources are essential for reducing greenhouse gas emissions and reaching state energy goals. The state's energy priorities for new energy resources put renewable technologies second only to efficiency and demand response technologies as the preferred resources to meet California's growing energy needs. Already 11 percent of the electricity delivered to California homes and businesses is obtained from renewable resources. The Renewables Portfolio Standard (RPS) requires that 20 percent of the state's electricity come from renewable sources by 2010. The Governor, the Energy Commission, and the CPUC have endorsed a further enhanced goal of 33 percent by 2020. New second and third generations of renewable energy technology will be developed through RD&D to assist in achieving these goals.

The Energy Commission's renewables research investments enable the increased use of renewable resources in California by identifying and addressing technology gaps hindering achievement of California's renewable energy portfolio standard. Research also supports the accelerated deployment of community-scale renewable energy sources and the integration of

renewable energy sources into building construction practices, including renewable energy heating and cooling.

For 2008, the Energy Commission expanded its renewable energy portfolio to include more geothermal, solar, wind, and biomass power plants, initiating \$20.3 million for renewables research. This significant expansion of research funds allocated to renewable resources reflects the priorities in the *2007 Integrated Energy Policy Report*.

The following examples illustrate some of the renewables research completed in 2008:

- **California Biomass Assessment.** Collaborated with the California Biomass Collaborative to post an updated California Biomass Assessment for 2007. The draft report quantifies and compiles gross and technically available resources into statewide and county-level inventories. The update concludes that state biomass resources are sufficient to supply a substantially larger amount of renewable electricity than is presently generated as well as serving as feedstock for biofuels and bio-products.
- **Wave Conversion Research Roadmap.** Released a report summarizing PIER research in wave energy conversion and discussing the next steps for research. The quality of California's wave energy resource is good in general and excellent in selected locations and has recently attracted the interest of the state's major investor-owned utilities. Since much of California's population and energy use occurs in coastal areas, the state benefits from this up-to-date, technically informed and objective assessment of an emerging supply technology.

Future research includes combining natural gas and electricity funding to address barriers to renewable energy integration at all levels of California's infrastructure – from central station power plants to residential and commercial buildings. These new programs represent a fundamental change in overall program emphasis, changing from the historical emphasis on incremental improvements over a wide range of renewable energy conversion technologies to an emphasis on anticipating and addressing the technical integration issues inherent in the rapid deployment and high penetration necessary to accelerate the penetration of renewable resources. This new emphasis on supply-side renewable energy integration complements a parallel increasing emphasis on energy efficiency and grid integration solutions for the state's transmission and distribution systems, including smart grid and demand response technologies.

## Advanced Electricity Generation

Advanced electricity generation research includes both utility-scale central power plants and on-site customer generation. The *2007 Integrated Energy Policy Report* recommends expanding reliance on new distributed generation (DG) resources, which can produce on-site electricity and which use natural gas to generate electricity more efficiently. The focus of the PIER

advanced generation research program is fossil-fueled DG systems interconnected to the utility distribution system. In 2008, \$6.7 million in contracts was awarded for advanced generation research.

A well-designed and well-operated type of DG system—often referred to as *combined heat and power* (CHP) or *combined cooling, heating, and power* (CCHP), which uses the waste heat from the electricity generation for on-site heating and cooling—can improve reliability of the electric utility grid at low cost. It can also achieve efficiencies as high as 80 percent—well above those of the newest natural gas combined-cycle power plant and without the power plant’s subsequent line losses due to long-distance transmission. Also, by taking advantage of the waste heat created during industrial processes and reducing transmission and distribution losses, CHP has the potential for greatly minimizing greenhouse gases. An important focus of this research category is developing analytical techniques for assessing the life-cycle environmental impacts of emerging renewable and DG technologies.

The following examples illustrate some of the advanced electricity generation research completed in 2008:

- **Partial-oxidation gas turbine (POGT).** An innovative technology that shows promise for unusually high efficiency power generation in industrial heat and power systems applications. The Gas Technology Institute demonstrated the technical feasibility of modifying a 200-kW gas turbine to a POGT system. Ten percent of the fuel energy is converted in the POGT to heat for electricity generation. The remaining 90 percent is converted to a hot hydrogen-containing synthesis gas plus steam, suitable for low NO<sub>x</sub>, low carbon monoxide combustion or as a hydrogen source.
- **Ultra-clean micro turbine boiler** with the boiler adapted for a CHP package. The benefits to California include: ultra-clean technology (California Air Resources Board DG 2007 Compliant); energy-efficient (CHP efficiency is approximately 80 percent); economical CHP Package (payback period is 2-3 years); significant criteria pollutant and greenhouse gas emission reductions; and very large commercialization potential.
- **100-kW CHP system integrated with inverter technology providing grid-independent variable speed operation.** The benefits for this system include: standardized interconnection, variable speed operation for a higher base load, meeting 2007 emission limits with CHP credits and meeting Underwriter Laboratory Certification and Rule 21 compliance.

Future research includes the adaptation of stationary engines as distributed energy resources and CHP/CCHP applications; advancing current CHP/CCHP technologies to achieve higher thermodynamic efficiency, improved thermal load following capability, and “smart grid” capability; and organizing and hosting workshops that to identify policy options, RD&D solutions and environmental benefits for accelerated deployment of CHP/CCHP applications in California. PIER advanced generation research will embark on a strategic RD&D planning and roadmapping exercise that will identify and address barriers to advanced generation options



and its integration at all levels of energy infrastructure from large utility-scale central station power plants to distributed generation and CHP/CCHP applications. The strategic roadmap will provide inputs to the development of strategic solicitations for the program.

## Transmission and Distribution Infrastructure

SB 1250 specifically identified the importance of RD&D for new transmission infrastructure that will connect utility-scale renewables to the California electricity grid. The 2007 IEPR examined the current status of the California distribution system and encouraged additional RD&D efforts. A major new PIER initiative involves research supporting the statewide development of a “smart grid.” In 2008, \$4.1 million in contracts was awarded for transmission and distribution infrastructure research.

PIER transmission and distribution research focuses on improving California’s electric grid reliability and operational performance levels; develops new technologies that can help increase the amount of renewable resources being used and reduce transmission energy losses; and supports the management and use of customer resources, including distributed renewable energy, combined heat and power, demand response, energy storage, and reduced greenhouse gas emissions at the distribution level.

A key research goal is to improve the state’s transmission and distribution grid used to carry electricity generated from renewable energy resources. To meet this goal, the PIER program funds transmission and distribution research projects that will create a California “smart grid” system with the ability to integrate more renewable energy resources, support the increasing use of renewable energy by all customers, and provide new and innovative options to meet California’s energy needs. Working in collaboration with California’s utilities, the PIER program has initiated research projects to evaluate the use of smart grids to accommodate renewable and distributed resources, expand the capacity and improve the operational reliability of the transmission and distribution system. PIER transmission research also includes improving grid load-modeling capabilities to address the unique performance of new energy efficient residential air conditioners, and minimize the grid impacts of extreme events caused by natural disasters and unexpected system failures.

The following examples illustrate the PIER transmission research initiated in 2008:

- **New Wind Generator Model.** Initiated a project to model the dynamic behavior of the wind generators used within transmission control areas throughout California and the western states interconnection (WECC) to balance the supply and demand for electricity to avoid outages or economic inefficiencies. The wind turbine models that are currently used in transmission system planning and reliability analysis are known to be inaccurate because they do not correctly represent the new generation of wind machines. Incorrect or uncertain analysis of the impacts of wind farms on the grid will adversely affect reliable and economic operation of the California electric delivery system.

- **Intelligent Software Agents.** Initiated a research project to use intelligent software agents to control and match the needs of the grid with the capabilities of electric energy storage units.
- **Using Micro-sensors to Diagnose Underground Cables.** Initiated a research project to test new approaches – based on new micro technologies and sensors – that can diagnose and establish the remaining life of tens of thousands of miles of underground cable in California. The program plans to deploy these micro sensors on the distribution system to relay system condition information cheaply and quickly to system operators. These real-world monitors will help ensure that equipment is operating safely and reliably.

Future research includes the placement and use throughout California of grid-monitoring devices using new synchrophasor technology that provides time-synchronized high-resolution data previously unavailable to grid operators. Grid operators describe the improved situational awareness that synchrophasor technology-based software tools offer as “driving with your eyes wide open” as opposed to “opening them once every 4 seconds” which is the visibility and resolution provided by the current grid-monitoring technologies. Synchrophasor measurement units can provide the grid’s transmission controllers insight into grid stability that is not available otherwise. PIER is also developing displays and tools – for example, using advanced techniques to mathematically integrate and consolidate critical operational data – that present information in an easily usable format so the operators can respond rapidly to changing grid conditions. Additionally, PIER transmission research is developing and testing new intelligent agent technology that can help grid operators respond rapidly when renewable resources have unplanned changes in energy output.

Advanced distribution automation technologies (such as sensors, processors, communicators, and switches) can more efficiently control and monitor electrical distribution system operations by providing intelligent monitoring and transferring critical information in real time to system operators. Currently, there is a very limited monitoring of distribution systems, and this is predominantly through radio signals. This automation could be cost-effectively integrated into existing and new systems to increase the distribution system’s reliability (decreased duration and frequency of power outages), efficiency (system and energy loss savings), and flexibility (by allowing higher penetrations of distributed generation resources).

## Energy-related Environmental Research

The PIER program research includes the development of energy technologies that provide increased environmental benefits.<sup>8</sup> PIER environmental research sponsors energy-related environmental research in the following four areas: climate science, aquatic research, air quality research, and terrestrial research. In 2008, \$7.9 million in contracts was awarded for energy-related environmental research.

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<sup>8</sup> Public Resources Code section 25620.1

California's electricity generation currently accounts for 25 percent of California's greenhouse gases, which affect local and global climate. Natural gas consumption from stationary sources contribute approximately one-third of the carbon dioxide (CO<sub>2</sub>) emissions from the combustion of fossil fuels in California. The Energy Commission initiated research in 2001 with an exploratory study on the impacts of climate change on major sectors of the economy. This research and other studies suggest that climate change is so potentially harmful to the future of energy resources, and could affect energy demand so significantly, that climate change research must be an energy priority.

In 2003, the Energy Commission developed a long-term climate change research plan and created the California Climate Change Center, a virtual research institution with diverse climate research activities based at several universities and research institutions throughout California. Its main objective is to develop the tools and information needed to identify: (1) how climate change affects energy supply and demand in California, (2) plausible climate change scenarios for California, (3) how the physical impacts of climate change would affect California's environment and economy, and (4) the merits of different mitigation and adaptation strategies that would particularly effect California energy supply or demand.

Examples of accomplishments in the PIER environmental research program during 2008 include:

- **PACT Tool.** Developed a model, in partnership with Southern California Edison, to help analyze and communicate complicated energy facility siting decisions to policy makers and various stakeholders. The model, known as the Planning Alternative Corridors for Transmission (PACT) tool, inputs environmental and engineering information relevant for proposed energy developments to be compliant with California's Environmental Quality Act. The model allows utility and regulatory planners to conduct an analysis, and all stakeholders to view, investigate, and understand the analysis. Beginning in 2009, PACT will be demonstrated and validated through the development of a California Desert Natural Communities Conservation Plan to facilitate compliance with Executive Order S-14-08 to complete an NCCP and reduce permitting processing time for renewable energy developments by 50 percent.
- **WESTCARB Phase III Funding.** Received a \$65.6 million grant from the U.S. DOE to co-fund Phase III of the West Coast Regional Carbon Sequestration Partnership (WESTCARB). Established in 2003, WESTCARB is one of seven regional research partnerships to explore opportunities to capture carbon dioxide from the atmosphere and store it securely underground. Phase III is a 10-year project to conduct a commercial-scale carbon capture and sequestration demonstration to validate the feasibility, safety, and efficacy of storage in deep geologic formations. This research supports AB 32 and SB 1250 goals to advance technologies to reduce greenhouse gas emissions, and AB 1925 requirements to recommend how the state can develop parameters to accelerate the adoption of cost-effective geologic sequestration strategies for the long-term management of industrial CO<sub>2</sub>.

- **2008 Title 24 Building Efficiency Standards.** Completed research to better understand how new home owners use windows, doors and mechanical ventilation devices. This study was complemented by a field test of actual indoor air quality and ventilation practices of new homes. These studies found that the new single-family detached homes in California are built relatively tight, that many occupants do not open windows and that, in those homes where the windows/doors are not opened for ventilation (e.g. for security, noise, odor, dust, thermal comfort concerns), the outdoor air exchange rates are typically low and indoor concentrations of some air contaminants with indoor sources can be significantly elevated. These results were used by the Energy Commission to develop the 2008 Title 24 Building Energy Efficiency Standards requiring mechanical ventilation in new homes to provide a dependable and continuous supply of outdoor air to the residence.

The PIER environmental research program will continue to sponsor studies critical to inform the Climate Action Team and the California Natural Resources Agency on impacts and adaptation strategies so that California is in the position to respond more proactively to climate change. In response to the CARB's planned implementation of a cap-and-trade program under AB 32 and the possibility that electric and natural gas utilities will be permitted to meet a portion of their emission reduction obligations through the purchase of emission offsets, research will be designed to identify and characterize potential sources of offsets such as carbon sequestration in soils, reductions of nitrous oxide emissions from the application of fertilizers, reductions of methane emissions from landfills beyond any regulatory requirements, and other source categories that may be allowed to generate offsets under the regulations implementing AB 32.

The program will also fund research to support implementation of the renewable portfolio standard, carbon capture and sequestration, climate change impacts on finite water resources, and additional improvements to hydropower operations. Research will investigate the potential environmental effects of wave energy technologies that may be deployed off the California coast to proactively provide information needed by decision-makers in anticipation of this energy source potentially becoming more prominent in the future.

Other research will continue to investigate the trade-offs between efficient zero-energy buildings and indoor air quality to inform building efficiency standards, evaluate local air quality implications of strategies to deploy more distributed generation and combined heat and power resources to augment energy needs, and determine burner performance when using liquefied natural gas to promote efficient and safe use of this alternative natural gas energy source. To respond to California's aggressive goals to increase use and in-state production of renewable biofuels, PIER environmental research will develop a plan to identify research needed to better understand the air quality implications of increased use of alternative fuels.

## Advanced Transportation Technologies

The PIER transportation research investments seek to advance science or technology in three areas: alternative and conventional fuels, vehicles, and land use. Alternative fuels research aims to reduce costs and increase availability of “upstream” resources, find more-efficient, less-polluting energy conversion methods, and improve the efficiency and safety of alternative fueling infrastructure. Vehicle research concentrates on improving efficiency and deploying alternative fuel vehicles. Land use research will develop better tools and methods to offer better choices for reducing personal vehicle dependence.

Use of public interest research investments in transportation was first authorized by Senate Bill 76 (Chapter 91, Statutes of 2005), which directed development of alternative fuels and vehicle efficiency technologies to benefit electric and natural gas ratepayers. Senate Bill 1250 subsequently sharpened the Energy Commission’s research focus and added transportation research to its priorities. Both laws require the Energy Commission to coordinate with the CARB on new transportation RD&D efforts. In 2008 the PIER program initiated \$2.9 million of energy-related transportation research.

The following examples illustrate some of the transportation-related energy research completed in 2008:

- ***Natural Gas Vehicle Research Roadmap***, which describes the strategic RD&D needed to enhance the viability of the natural gas vehicle (NGV) market in California. The roadmap was developed with advice and input invited from the CARB, industry stakeholders, and environmental groups, thus assuring the alignment of energy and air quality policy objectives. Pursuing strategic public interest research investment that accelerates NGV production, infrastructure, and usage in turn expands the potential contribution of an existing alternative fuel to California’s transportation policy goals.
- **Re-established the Natural Gas Vehicle Technology Forum** in partnership with the National Renewable Energy Laboratory. The forum brings together stakeholders from all aspects of the NGV market to share insights to the barriers and solutions they have encountered. The forum supports California’s goal to research, develop and demonstrate engines and vehicles capable of using alternative fuels, new and retrofitted, and to expand their availability in California.
- **Co-sponsored the Plug-in 2008 Conference**, which was specifically dedicated to plug-in electric hybrid technology in California. The 2007 IEPR recognizes the value of plug-in hybrid electric vehicles and recommends that: “The state should develop partnerships with original equipment manufacturers to demonstrate plug-in hybrid electric vehicles, assess consumer demand for these options, and support early incentives to reduce initial consumer cost.” The 3-day conference attracted more than 450 paid registrants.

Future research includes efforts to accelerate research and development of advanced natural gas engine concepts for application in heavy-duty vehicles, operated in fleets throughout California; improve electric vehicle traction batteries and reduce battery costs; reduce transportation

energy consumption and greenhouse gas emissions from personal vehicle use; and identify and explain the many factors that influence people's travel-related choices, including their transportation needs and abilities, the quality and affordability of transportation options, the degree to which various transportation modes are connected, the impact of land use patterns and urban form, and the quality of mobility substitutes such as telecommuting. Results of this research will help identify opportunities to reduce reliance on personal vehicles, which could lead to improvements in the sustainability of California's communities.

## Chapter 4: Ensuring RD&D Benefits

The PIER program celebrated its 11<sup>th</sup> birthday in 2008. During these 11 years the Energy Commission invested more than \$587.7 million of public funds in a diversified portfolio of projects supporting policy on a broad, interrelated set of energy issues. The general goal of the program is to develop, and help bring to market, energy technologies that provide increased environmental benefits, greater system reliability, and lower system costs. Importantly, the Energy Commission's research funds also leverage federal, private industry, and other funding sources to augment research interests and bring additional financial benefits to California.

The leveraged funding can be substantial, as demonstrated by the U.S. DOE \$65.6 million grant in 2008 to the Energy Commission for Phase III of the WESTCARB research program. This single grant exceeds the total amount of PIER electricity research funding for the entire year and more than triples the amount allocated in 2008 to the Energy Commission for natural gas research. In 2008 the Energy Commission leveraged \$15.3 million in co-funding provided by other partners for PIER research. During 1997 through 2007, the Energy Commission leveraged \$410.9 million in co-funding and \$13.7 million in federal grants to complement PIER research.

Chapter 3 highlights some of the notable results PIER research produced in 2008. These projects benefit California's citizens and businesses today and in the future. To ensure that the public interest energy RD&D portfolio continues to provide tangible benefits to California within the broader context of national and international efforts to address energy research needs and opportunities, projects within the PIER program are evaluated on a periodic basis.

### Benefits to California

Benefits derived from publicly-funded energy research can be represented by a variety of types of gains to society. The variety of technologies funded and markets served by PIER projects require that the framework of benefits assessment be broad enough to capture them and robust enough to be valid.

The PIER benefits assessment project, begun in 2008, now dedicates a full-time staff person and uses contractors to bring specialized expertise to assess the benefits of individual research projects and the cumulative benefits provided by all these projects. Three categories of benefits have been identified that accrue to California ratepayers from the activities of the PIER program: economic benefits, environmental benefits, and security benefits.

#### ***Economic***

Economic benefits are based on changes in the total market value of goods and services that can be produced in the California economy as a result of the new technologies and research created through PIER projects.

A project to develop and deploy high-efficiency external power supplies provides a good example of a PIER project that has yielded economic benefits to the ratepayer. These ubiquitous “little black boxes” are attached to nearly every electronic device purchased in California today. This project proved that the 20-40 percent efficiency for older designs could be improved to 65-85 percent with the new design. With the adoption of requirements in Title 20 Appliance Efficiency Standards mandating this technology on all external power supplies sold in California, early estimates of the net economic benefits to ratepayers range from \$100 million to \$200 million over the next 10 years.

## ***Environmental***

Environmental benefits are based on changes in the quality of the environment that have occurred or may occur as a result of new technology or systems research within the PIER program. These benefits accrue to the California ratepayer in two key ways. First, they reduce the emissions of toxic substances from energy-related activities in the state and, second, they reduce the impacts on California’s ecosystem from all energy-related activities. The PIER program is developing standard measures for environmental improvements from RD&D activities.

The Integrated Forecasting and Reservoir Management (INFORM) project is a promising, ongoing project aimed at achieving just such a positive environmental result. The INFORM tool is a hydrologic model that combines short- and long-term weather and water table forecasts with the state’s electrical, agricultural, and flood control policies to generate recommendations for water release from California’s network of dams. While the project is not yet concluded, early results indicate that the use of this tool from 2006 through 2008 would have increased the total available water resources by 1.5 million acre feet by the end of 2008 and produced an additional 700 GWh from hydroelectric production valued at approximately \$40 million.

## ***Security***

Security benefits are based on changes in the probability or severity of unusual energy-related events that would adversely impact the overall economy, public health and safety, or the environment. An improvement in California’s energy infrastructure security means that ratepayers experience less frequent and less dramatic effects on their lives from energy-related events. While there is no way to prevent every disruption, the PIER program works to identify and develop technology and tools that reduce the duration and severity of such disruptions.

An example of such a technology is the Real Time Display Monitoring System (RTDMS) that measures frequency disruptions on California’s electrical grid at a rate of up to 20 times per second. Such tiny fluctuations can lead to wide ranging blackouts and disruptions if left unchecked. Preliminary estimates of the impact of this single project indicate that 30 percent of outages in California electrical service territory could be avoided by the use of this new technology.



## Managing Risks in RD&D

Studies on the success of industrial and other RD&D programs<sup>9</sup> indicate that only a few research products actually become highly successful. Consistent with legislative direction, the Energy Commission's RD&D portfolio is balanced along a risk continuum. To help mitigate the inherent riskiness of research, the Energy Commission developed performance metrics to deal with an incremental, phased approach to research, in which results are evaluated and benefits and risks are assessed before committing to the next phase. These metrics for quantifying each phase of a research project become part of the project's deliverables. As research concepts get closer to commercialization, the Energy Commission looks to reduce its share of funding and looks to hand off promising products and ideas to venture capitalists and others, such as California's Emerging Technologies programs run by California utilities. The Emerging Technologies programs offer incentives to consumers to assist in getting new products established in the marketplace.

There is no way to eliminate all risk in RD&D projects. On the contrary, one of the key reasons that competitive markets fail to invest adequately in RD&D is the inherent risk that a project will fall short of its intended results. For example, in 2008 the bankruptcy of the Calpine Corporation prompted the Energy Commission to cancel four PIER research grants, totaling \$1.4 million, because the risk of failure was too great. Rather than continue funding these high risk projects, the Energy Commission redirected remaining funds to other productive contracts.

Other projects do not meet all of their technical economic objectives, and, as a consequence, do not receive follow-up support through the Energy Commission or in the marketplace. Even in these cases, however, the Energy Commission still gets valuable information. A higher rate of failure is expected for projects that are on the basic research end of the continuum than for projects that are close to market (such as engineering deployment or demonstration).

## Looking Forward

### ***PIER Advisory Board to Provide Strategic Guidance***

The Energy Commission formed an advisory board in 2007 and the board met in 2008 to provide strategic guidance on funding priorities for PIER. The advisory board is intended to consist of representatives from the California Public Utilities Commission (CPUC), consumer organizations, environmental organizations, and the investor-owned utilities. Additionally, six members of the California Legislature meet with the advisory board and participate in its activities.

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<sup>9</sup> Bosworth and Jobome, 1999

The advisory board, meeting again in the spring of 2009, will reflect new appointments to the Energy Commission, a new Research and Development Committee, new legislators, and potential new members from other representative organizations. Legislative leadership has identified its six members and other representatives have been contacted. The new Advisory Board will be asked to assess the past and current research portfolio direction; help develop a strategic plan that anticipates and accommodates new energy research needs; and help determine how best to pursue the Energy Commission's collaboration and coordination with other state agencies that is occurring in critical energy-related areas, such as climate adaptation and mitigation.

### ***New Added Credit for California Businesses in Contract Evaluation***

The PIER program's ability to access the entire research community has been helpful to secure the services of the best researchers, no matter where they are located. All projects that are funded, however, must benefit California ratepayers. As shown in Figure 4, nearly 82 percent of funds provided by the PIER program since 1998 went to businesses and organizations based in either northern or southern California. In 2008 AB 2267 (Fuentes, Chapter 573, Statutes of 2008) directed the Energy Commission to give priority to "California-based entities." Implementing this new law, the Energy Commission awards preference points to proposals when the bidder meets the criteria for a California-based entity.

**Figure 4: Distribution of PIER Funds Across California Electricity and Natural Gas Programs (1998-Present)  
(\$ Millions)**



Even where funding is provided to out-of-state organizations, the research is most often for projects conducted within California or part of cooperative research with other state entities and national research organizations. Cooperative research agreements allow “pooling” of research dollars from many entities for common research purposes and help avoid unnecessary duplication of research efforts. Cooperative research also leverages PIER funding and provides exceptional value to California citizens. For example, the program has contracted with the Electric Power Research Institute (EPRI), whose membership includes many electric utilities. In this instance, pooling PIER funds with funds from multiple EPRI partners is allowing research to develop better ways to monitor and transfer power throughout the western states to avoid power disruptions and improve energy security for California.

### ***How Benefits Reach Ratepayers***

The benefits of the PIER program reach California ratepayers through a variety of mechanisms. The most common is through the marketplace, where PIER-supported technologies reduce the purchase price and improve the efficiency of devices used by consumers. For example, PIER research led to the completion of an industry-approved reference design for a new thermostat that can allow customers to participate in demand response programs and tariffs, thereby reducing their energy consumption and energy costs. As a direct result of PIER’s investment, the project led to the development of a thermostat costing \$100 to \$200 less than previous devices. This price change could result in a potential \$1 billion to \$2 billion savings to consumers over a 10-year period.

Yet another research benefits path is through ratepayers’ monthly energy bills. PIER projects help reduce the cost of generating electricity by making the process more reliable and efficient, while reducing adverse environmental impacts. PIER projects also benefit the customer through codes and standards that provide energy savings across the entire state.

PIER research is constantly advancing the boundaries of what is cost effective. Since 1978, California’s Title 24 Building Efficiency Standards and Title 20 Appliance Efficiency Standards have saved ratepayers more than \$56 billion in electricity and natural gas costs. These standards are estimated to save an additional \$23 billion by 2013. Some of the PIER projects used in the most recent changes to the 2008 Title 24 Buildings Standards include Light Emitting Diode (LED) exterior lighting, LED night lighting in hotel bathrooms, measures to improve indoor air quality and ventilation efficiency, load shedding florescent ballasts, cool roofs, integrated classroom lighting system design and duct sealing measures to reduce energy losses.

### ***New Benefits Evaluation of PIER Activities***

A 2004 study indicated the Energy Commission’s RD&D program’s economic benefits far exceed the costs of the program.<sup>10</sup> This report estimated the total life-cycle benefits of 33

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<sup>10</sup> *Evaluation of the Benefits to California Electric Ratepayers from the Public Interest Energy Research Program, 1998-2003*, Gerald Pine, Jing Tong, Xun Zhou

products receiving Energy Commission RD&D funding that were commercialized from 1998-2003. The report shows that the projected benefits from the program through 2003 were between 1.3 and 3.4 times greater than the cost of program operation. The study also indicated that the projected benefits are understated and those figures could be closer to two to five times the cumulative cost of the program.

Applying this range of 1.3 to 3.4 to the PIER project portfolio would suggest that the program might have returned as little as \$764 million or as much as \$2 billion in economic benefits over its 10-year existence. We believe, however, this range of economic benefits estimate may be significantly understated as the report did not fully quantify the spillover and societal benefits that can be attributed to the Energy Commission's research efforts. To capture these types of benefits, the Energy Commission is conducting research to provide the foundation for an ongoing process of evaluation and feedback.

The Energy Commission plans to refine the methods developed in this research each year, with the goal of creating a robust and ongoing benefits evaluation program and a comprehensive, science-based evaluation effort. The methodology will be applied to more PIER activities in the future, with the expectation that the evaluation methodology will be further improved and help ensure that the RD&D program continues to focus on the projects most beneficial to California ratepayers.

## APPENDIX- 2008 Individual Projects

This appendix contains a summary of the project work performed during the calendar year of 2008. The table includes the SB 1250 goal, contract number, project title, amount, start date, and total funding for each area. During 2008, the energy Commission allocated a research budget of \$80.4 million. PIER research projects initiated in 2008 totaled \$47.4 million. The remaining \$33 million is not included in the table below because it will not result in active project contracts until 2009.

### Summary of Calendar Year 2008 Projects by SB 1250 Policy Goals

| SB 1250 Policy Goals                  | Project Funding Total | Project Count |
|---------------------------------------|-----------------------|---------------|
| Transportation                        | \$2,844,729           | 8             |
| Energy Efficiency and Demand Response | \$5,462,708           | 29            |
| Advanced Electricity Generation       | \$6,570,762           | 13            |
| Renewables                            | \$19,915,656          | 45            |
| Transmission and Distribution         | \$4,054,895           | 8             |
| Climate/ Environmental                | \$7,771,109           | 24            |
| Program Administration                | \$827,902             | 14            |
| <b>Grand Total</b>                    | <b>\$47,447,761</b>   | <b>141</b>    |

## Details of Calendar Year 2008 Projects by SB 1250 Policy Goals

| SB1250 Goal                                  | Contract Number | Project # | Provider Name   | Project Title  | Project Amount       | Start Date |
|--|-----------------|-----------|---|--|----------------------|------------|
| <b>Grand Total</b>                           |                 |           |   |  | <b>\$ 47,447,761</b> | <b>137</b> |
| <b>Transportation</b>                        |                 | <b>8</b>  |   |  | <b>\$ 2,844,729</b>  |            |
| Transportation                               | BOA-99-188-P    | 1         | UC Riverside  | White Paper on Hydrogasification   | \$ 50,000            | 9/30/2008  |
| Transportation                               | BOA-99-191-P    | 1         | UC Berkeley   | Potential Benefits of Transportation Electric Fuel Implementation in California  | \$ 83,608            | 3/31/2009  |
| Transportation                               | BOA-99-193-N    | 1         | Bevilacqua-Knight, Inc.   | Natural Gas Vehicle Research Roadmap Peer Review   | \$ 20,000            | 2/27/2009  |
| Transportation                               | BOA-99-195-P    | 1         | The Regents of the University of California, Office of the President - CIEE | Tire Rating System Analysis  | \$ 150,000           | 9/30/2008  |
| Transportation                               | BOA-99-207-P    | 1         | UC Los Angeles  | Potential Targets and Benefits of Integrated Energy Smart Communities Research in the PIER program                               | \$ 64,029            | 5/29/2009  |
| Transportation                               | MRA-02-078      | 1         | Bren School of Environmental Science & Management - UC Santa Barbara        | Biofuels and Biodiversity in California  | \$ 397,000           | 11/26/2010 |
| Transportation                               | NCI-06-022-P-R  | 1         | Navigant Consulting, Inc.   | Analysis of Transportation Vehicle Technology RD&D Opportunities   | \$ 80,092            | 2/28/2009  |
| Transportation                               | TMP-FED-384     | 1         | National Energy Technology Laboratory                                       | Automotive Thermoelectric HVAC Development and Demonstration Project   | \$ 2,000,000         | 12/1/2011  |
| <b>Energy Efficiency and Demand Response</b> |                 | <b>25</b> |   |  | <b>\$ 5,462,708</b>  |            |
| Energy Efficiency and Demand Response        | 500-01-043      | 5         | The Regents of the University of California, Office of the President - CIEE | Decision Support Tool for Demand Response Trigger System to Connect Retail to Wholesale Electricity Markets (EPRI)               | \$ 249,989           | 1/31/2009  |
| Energy Efficiency and Demand Response        | 500-01-043      | 6         | The Regents of the University of California, Office of the President - CIEE | Requirements, Architecture and Tools for Implementing Reliable Command and Control for a Demand Responsive Energy Grid (EnerNex) | \$ 250,039           | 1/30/2009  |
| Energy Efficiency and Demand Response        | 500-03-026      | 27        | Lawrence Berkeley National Laboratory                                       | DR Technology in Industrial Wastewater   | \$ 170,000           | 3/1/2009   |
| Energy Efficiency and Demand Response        | 500-05-032      | 5         | Lawrence Berkeley National Laboratory                                       | Energy and Demand Savings from Sealing Exhaust Ductwork  | \$ 100,000           | 12/31/2008 |
| Energy Efficiency and Demand Response        | 500-07-022      | 1         | Association of California Water Agencies                                    | California Time of Use Water Meter Case Study  | \$ 399,286           | 10/15/2010 |

| SB1250 Goal                           | Contract Number | Project # | Provider Name                                    | Project Title  | Project Amount | Start Date |
|---------------------------------------|-----------------|-----------|--|--|----------------|------------|
| Energy Efficiency and Demand Response | 500-07-033      | 1         | White Box Technologies, Inc.                     | Update of Certified Energy Commission California Weather Data and Weather File Creation Methodologies              | \$ 300,000     | 8/3/2010   |
| Energy Efficiency and Demand Response | 500-07-034      | 1         | National Renewable Energy Laboratory             | Software Tools for Standards Development & Compliance  | \$ 1,000,000   | 6/1/2011   |
| Energy Efficiency and Demand Response | 500-07-040      | 1         | American Council for an Energy Efficient Economy | Technologies and Practices Evaluations   | \$ 12,000      | 6/1/2009   |
| Energy Efficiency and Demand Response | 500-07-046      | 1         | Lawrence Berkeley National Laboratory            | Demand Controlled Ventilation: Research for Improving the Specifications in Title 24                               | \$ 870,000     | 6/30/2011  |
| Energy Efficiency and Demand Response | 500-08-008      | 1         | Southern California Edison                       | Self-Audit Of Wastewater Treatment Processes To Achieve Energy Optimization, Phase 1                               | \$ 300,000     | 2/28/2010  |
| Energy Efficiency and Demand Response | 500-98-014      | 245       | Texas Engineering Experiment Station             | Novel heat transfer fluid for heating, ventilating, and air conditioning (HVAC), and microelectronics applications | \$ 93,906      | 3/31/2009  |
| Energy Efficiency and Demand Response | BOA-99-187-P    | 1         | Lawrence Berkeley National Laboratory            | Cool Communities Early Action Research   | \$ 22,400      | 1/30/2009  |
| Energy Efficiency and Demand Response | BOA-99-194-P    | 1         | Lawrence Berkeley National Laboratory            | Recommendations for energy benchmarking programs and opportunities to meet California goals                        | \$ 112,000     | 10/31/2008 |
| Energy Efficiency and Demand Response | BOA-99-196-P    | 1         | Lawrence Berkeley National Laboratory            | Integrate Data Interoperability Research into Guideline Document   | \$ 56,000      | 12/31/2009 |
| Energy Efficiency and Demand Response | BOA-99-198-P    | 1         | Western Cooling Efficiency Center - UC Davis     | Advancement of Western Cooling Efficiency  | \$ 224,000     | 6/30/2009  |
| Energy Efficiency and Demand Response | BOA-99-199-P    | 1         | California Lighting Technology Center - UC Davis | Partnership for Energy Efficient Lighting  | \$ 369,715     | 5/31/2009  |
| Energy Efficiency and Demand Response | BOA-99-200-P    | 1         | Center for the Built Environment - UC Berkeley   | Advanced Systems Technology Development  | \$ 250,000     | 4/30/2009  |
| Energy Efficiency and Demand Response | BOA-99-203-P    | 1         | Lawrence Berkeley National Laboratory            | Title 24 Technical Support for Residential HVAC  | \$ 56,000      | 10/20/2009 |
| Energy Efficiency and Demand Response | BOA-99-204-P    | 1         | Lawrence Berkeley National Laboratory            | UC Merced: Measured Performance Validation   | \$ 33,600      | 4/30/2009  |
| Energy Efficiency and Demand Response | BOA-99-205-P    | 1         | Lawrence Berkeley National Laboratory            | Research Opportunities in Emerging and Under-Utilized Energy-Efficient Industrial Technologies                     | \$ 84,000      | 12/31/2009 |
| Energy Efficiency and Demand Response | ICF-06-025-P-R  | 1         | Energy & Environmental Economics, Inc.           | Carbon Calculator for California Buildings using Electricity Sector Marginal Emissions Profile                     | \$ 44,752      | 7/31/2008  |
| Energy Efficiency and Demand Response | ICF-06-026-P-R  | 1         | L Monte Information Services                     | Requirements Engineering Services for the PIER Buildings Program Area  | \$ 49,959      | 5/30/2009  |
| Energy Efficiency and Demand Response | ICF-06-031-P-R  | 1         | Energy & Environmental Economics, Inc.           | Carbon Calculator for California Buildings Electricity Sector Emission Profile - Phase 2                           | \$ 17,762      | 4/30/2009  |
| Energy Efficiency and Demand Response | KEMA-06-018-P-R | 1         | Energetics Incorporated                          | RD & D roadmap for improving energy efficiency in California's food processing industry                            | \$ 47,300      | 4/30/2009  |

| SB1250 Goal                            | Contract Number | Project # | Provider Name   | Project Title   | Project Amount       | Start Date |
|--|-----------------|-----------|---|---|----------------------|------------|
| Energy Efficiency and Demand Response  | UC MR-026       | 10        | SYNAPSE Energy Economics, Inc   | Air Emissions Reductions Through Energy and Peak Load Reductions and Renewable Generation | \$ 350,000           | 3/24/2009  |
| <b>Advanced Electricity Generation</b> |                 | <b>13</b> |   |   | <b>\$ 6,570,762</b>  |            |
| Advanced Electricity Generation        | 500-07-031      | 1         | California Department of Water Resources                                    | Indemnity Agreement for the Carbon Dioxide Sequestration Project at Grizzly Slough        | \$ 1                 | 3/28/2028  |
| Advanced Electricity Generation        | 500-98-014      | 246       | Northwestern University   | Novel Solid Oxide Fuel Cell Anodes for Use with Coal- and Biomass-Derived Syngas          | \$ 94,993            | 3/31/2009  |
| Advanced Electricity Generation        | 500-98-014      | 249       | CleanEngen Group LLC  | Air Independent Internal Oxidation Steam Generator  | \$ 95,000            | 9/13/2009  |
| Advanced Electricity Generation        | 500-98-014      | 251       | CHA Corporation   | Microwave-Induced Destruction of NOx and H2S in Dairy Digester Reciprocating Engines      | \$ 95,000            | 7/20/2009  |
| Advanced Electricity Generation        | 500-98-014      | 254       | UC Berkeley   | Novel Adaptation of 3-Way Catalyst for NOx Reduction in Exhaust of Landfill Gas Engines   | \$ 92,500            | 7/20/2009  |
| Advanced Electricity Generation        | ICF-06-024-P-R  | 1         | ICF Resources, LLC  | RD&D Analysis and Targets for EPAG  | \$ 169,998           | 9/30/2009  |
| Advanced Electricity Generation        | PIR-07-003      | 1         | CMC-Engineering   | Microturbine-Based Efficient Heat and Power Systems (EHPS)                                | \$ 1,499,733         | 3/30/2012  |
| Advanced Electricity Generation        | PIR-07-004      | 1         | Brayton Energy, LLC   | 400 kW Intercooled-Recuperated Microturbine   | \$ 808,000           | 3/30/2012  |
| Advanced Electricity Generation        | PIR-07-005      | 1         | CMC-Engineering   | Packaged Microturbine / Boiler CHP System   | \$ 535,954           | 3/30/2012  |
| Advanced Electricity Generation        | PIR-07-006      | 1         | ICF International   | Dehumidification/Heating Combined Heat and Power System                                   | \$ 460,062           | 3/30/2012  |
| Advanced Electricity Generation        | PIR-07-007      | 1         | CMC-Engineering   | Microturbine-Based CHP for Thermal Oxidizers  | \$ 733,905           | 3/30/2012  |
| Advanced Electricity Generation        | PIR-07-008      | 1         | Southern California Gas Company   | Ultra-Low Emission Integrated CHP Technology Development                                  | \$ 1,484,179         | 3/31/2012  |
| Advanced Electricity Generation        | PNG-07-006      | 1         | Gas Technology Institute  | Integrated CHP Using Ultra-Low-NOx Supplemental Firing                                    | \$ 501,437           | 3/21/2011  |
| <b>Renewables</b>                      |                 | <b>45</b> |   |   | <b>\$ 19,915,656</b> |            |
| Renewables                             | 500-06-056      | 1         | County of Kern Planning Department  | Tehachapi Wind Resource Area Expansion Study  | \$ 500,000           | 8/31/2010  |
| Renewables                             | 500-07-020      | 1         | Alternative Energy Systems Consulting, Inc.                                 | Agents for the Integration of Storage and Renewables                                      | \$ 1,150,000         | 6/18/2009  |
| Renewables                             | 500-07-021      | 1         | Horizon Wind Energy   | Meteorological Tower and Data Transfer  | \$ -                 | 12/31/2010 |
| Renewables                             | 500-07-036      | 1         | State Coastal Conservancy   | Ocean Energy Environmental Knowledge Gaps   | \$ 100,000           | 5/1/2009   |
| Renewables                             | 500-07-037      | 1         | The Regents of the University of California, Office of the President - CIEE | Transmission Grid Infrastructure Research Plan  | \$ 489,601           | 2/14/2010  |



| SB1250 Goal | Contract Number | Project # | Provider Name   | Project Title  | Project Amount | Start Date |
|-------------|-----------------|-----------|---|--|----------------|------------|
| Renewables  | 500-07-037      | 4         | The Regents of the University of California, Office of the President - CIEE | Transmission System Operation Research Plan  | \$ 516,440     | 2/14/2010  |
| Renewables  | 500-07-037      | 5         | The Regents of the University of California, Office of the President - CIEE | Underground Transmission Technology Solutions for Renewable Generation Transmission Integration and Protection from Natural Disasters  | \$ 173,000     | 9/2/2010   |
| Renewables  | 500-07-037      | 7         | The Regents of the University of California, Office of the President - CIEE | Wide-Area Energy Storage and Management System to Balance Intermittent Resources in the CAISO, BPA and PG&E Control Areas Phase II   | \$ 198,000     | 3/6/2009   |
| Renewables  | 500-07-037      | 8         | The Regents of the University of California, Office of the President - CIEE | Oscillation Detection and Analysis   | \$ 180,000     | 9/2/2009   |
| Renewables  | 500-07-037      | 9         | The Regents of the University of California, Office of the President - CIEE | Transmission Planning and Environmental Research Plan  | \$ 500,380     | 2/14/2010  |
| Renewables  | 500-07-037      | 10        | The Regents of the University of California, Office of the President - CIEE | Application of Modal Analysis for Grid Operation (MANGO) on the Western Interconnection  | \$ 360,000     | 1/8/2010   |
| Renewables  | 500-07-037      | 11        | The Regents of the University of California, Office of the President - CIEE | Adaptive Relaying Technology Development   | \$ 700,000     | 9/2/2011   |
| Renewables  | 500-07-037      | 12        | The Regents of the University of California, Office of the President - CIEE | Technology Transfer Activities Plan  | \$ 442,547     | 11/30/2011 |
| Renewables  | 500-07-037      | 15        | The Regents of the University of California, Office of the President - CIEE | Developing Tools for Online Analysis and Visualization of Operational Impacts of Wind and Solar Generation   | \$ 1,400,000   | 9/1/2011   |
| Renewables  | 500-07-038      | 1         | WaterReuse Foundation   | Energy Efficiency for Reclaimed Water and Water Reuse Projects   | \$ 650,000     | 6/30/2011  |
| Renewables  | 500-07-038      | 2         | WaterReuse Foundation   | Asses water use requirements and establish water quality criteria for the application of water reuse in energy , power, and biofuels production (WRF-08-TT-06-15)                          | \$ -           | 6/30/2011  |
| Renewables  | 500-07-038      | 3         | WaterReuse Foundation   | Renewable energy technologies and energy efficiency strategies: Guidelines for water desalination and reuse systems to optimize energy use and reduce greenhouse has emissions (WRF-08-13) | \$ -           | 6/30/2011  |
| Renewables  | 500-07-038      | 4         | WaterReuse Foundation   | Evaluation and optimization of emerging and existing energy recovery devices for desalinization and wastewater membrane treatment plants (WRF-08-14/TT-06-10)                              | \$ -           | 6/30/2011  |

| SB1250 Goal | Contract Number | Project # | Provider Name  | Project Title  | Project Amount | Start Date |
|-------------|-----------------|-----------|--|--|----------------|------------|
| Renewables  | 500-07-038      | 5         | WaterReuse Foundation  | Evaluating long and short term planning under climate change scenarios to better assess the role of water reuse (WRF-08-15/P-06-15)  | \$ -           | 6/30/2011  |
| Renewables  | 500-07-038      | 6         | WaterReuse Foundation  | Implications of future water supply sources on energy demands (WRF-08-16/TT-06-09)   | \$ -           | 6/30/2011  |
| Renewables  | 500-08-006      | 1         | The Regents of the University of California, Office of the President - CIEE    | Funding for UC Energy Institute to operate the Center for the Study of Energy Markets  | \$ 2,394,375   | 4/1/2012   |
| Renewables  | 500-08-010      | 1         | California Department of Fish and Game   | Validation of an Environmental Analysis Tool (PACT) for Renewable Energy Siting  | \$ 2,997,955   | 11/1/2010  |
| Renewables  | 500-98-014      | 237       | GC Environmental, Inc.   | UV-Photodecomposition of Siloxane  | \$ 95,000      | 5/31/2009  |
| Renewables  | 500-98-014      | 247       | University of Arkansas Division of Agricultural-Cooperative Extension Services | Thermochemical Processes Platforms to Utilize Crude Glycerin for Hydrogen Production and Electricity Generation  | \$ 95,000      | 1/30/2009  |
| Renewables  | 500-98-014      | 248       | C/e- Solutions, Inc.   | Novel energy generation process for wastewater treatment plant operations  | \$ 94,817      | 1/13/2009  |
| Renewables  | 500-98-014      | 252       | Evan Hughes  | Pomace and Woody Biomass for Renewable Biomass Power: Technical and Economic Feasibility   | \$ 95,000      | 7/31/2009  |
| Renewables  | 500-98-014      | 253       | UC Davis   | Wind Turbine Load Limiting Algorithm Verification Testing  | \$ 94,815      | 9/30/2009  |
| Renewables  | BOA-99-190-S    | 1         | The Regents of the University of California, Office of the President - CIEE    | To provide continued leadership in targeting areas of renewable energy research for RD&D support which would bring the greatest benefit to CA., and in the evaluation of benefits associated with RD&D programs and projects to improve CA's energy supply | \$ 246,086     | 2/28/2009  |
| Renewables  | BOA-99-192-P    | 1         | The Regents of the University of California, Office of the President - CIEE    | Renewable Integration Research Roadmap   | \$ 202,847     | 10/31/2008 |
| Renewables  | BOA-99-197-P    | 1         | The Regents of the University of California, Office of the President - CIEE    | Funding for UC Energy Institute to operate the Center for the Study of Energy Markets  | \$ 252,659     | 3/31/2009  |
| Renewables  | BOA-99-202-P    | 1         | The Regents of the University of California, Office of the President - CIEE    | Demand Response Control Future Work  | \$ 130,770     | 3/31/2010  |
| Renewables  | BOA-99-206-P    | 1         | Lawrence Berkeley National Laboratory  | Phasors  | \$ 235,200     | 3/31/2010  |
| Renewables  | BOA-99-209-P    | 1         | The Regents of the University of California, Office of the President - CIEE    | Strategic Planning Research for integration of Renewable Energy Collaboratives   | \$ 119,996     | 8/31/2009  |
| Renewables  | KEMA-06-019-P-R | 1         | KEMA, Inc.   | ESI Market Assessments and Technology Information on Smart Grid and Renewables Integration   | \$ 110,278     | 5/30/2009  |

| SB1250 Goal                          | Contract Number | Project # | Provider Name   | Project Title  | Project Amount      | Start Date |
|--------------------------------------|-----------------|-----------|---|--|---------------------|------------|
| Renewables                           | MRA-02-077      | 1         | UC Davis  | California Wind Energy Collaborative   | \$ 402,269          | 1/31/2009  |
| Renewables                           | PIR-06-002      | 1         | Renewable Energy Institute International, Inc.                              | Demonstration of an Integrated Biofuels and Energy Production System   | \$ 996,093          | 3/30/2011  |
| Renewables                           | PIR-07-001      | 1         | Growpro Inc.  | Develop and Operate a Wood Gasification System in a Commercial Environment in Northern California                            | \$ 199,500          | 3/31/2012  |
| Renewables                           | PIR-07-010      | 1         | Electric Power Research Institute (EPRI)                                    | Metrics-Based Evaluation of Storage at Wind Interconnection Points in California   | \$ 481,657          | 3/31/2012  |
| Renewables                           | PIR-07-012      | 1         | Silicon Valley Leadership Group   | Enabling Photovoltaic Markets in California Through Building Integration, Standardization and Metering in the Carbon Economy | \$ 747,253          | 3/31/2011  |
| Renewables                           | PIR-07-013      | 1         | Tilt Solar LLC  | Demonstration of a Novel, Low-Cost Two Axis Solar Tracking System  | \$ 246,816          | 3/30/2012  |
| Renewables                           | PNG-07-002      | 1         | Gas Technology Institute  | Production and Conditioning of High Sulfur Biogas for Fuel Cell Combined Heat and Power Generation                           | \$ 499,921          | 3/31/2012  |
| Renewables                           | PNG-07-003      | 1         | Sacramento Municipal Utility District                                       | Removal of Siloxane and H2S from Biogas using Microwave Technology   | \$ 267,381          | 3/3/2012   |
| Renewables                           | PNG-07-004      | 1         | Lawrence Berkeley National Laboratory                                       | Biogas-Powered 100kW Microturbine with Ultra-low Emissions for CHP Applications  | \$ 500,000          | 3/31/2012  |
| Renewables                           | PNG-07-005      | 1         | Diversified Energy Corporation  | Reducing California Industrial Natural Gas Consumption Through Advanced Biomass Gasification                                 | \$ 500,000          | 12/31/2012 |
| Renewables                           | TMP-FED-249     | 1         | National Renewable Energy Laboratory  | WECC Wind Model Validation Data for California   | \$ 550,000          | 8/31/2010  |
| <b>Transmission and Distribution</b> |                 |           |   |  |                     |            |
|                                      |                 | <b>8</b>  |   |  | <b>\$ 4,054,895</b> |            |
| Transmission and Distribution        | 500-07-030      | 1         | University of Southern California   | Strategies to Minimize All Hazards Impact on the Southern California Electrical Power Grid                                   | \$ 500,000          | 3/9/2010   |
| Transmission and Distribution        | 500-07-037      | 2         | The Regents of the University of California, Office of the President - CIEE | Development of SmartWires Transmission Line Impedance Control Technology   | \$ 70,000           | 9/2/2010   |
| Transmission and Distribution        | 500-07-037      | 13        | The Regents of the University of California, Office of the President - CIEE | Seismic Performance of Transformer Bushings  | \$ 250,000          | 9/2/2010   |
| Transmission and Distribution        | 500-07-037      | 14        | The Regents of the University of California, Office of the President - CIEE | Improved Seismic Performance of Substation Insulators  | \$ 346,500          | 3/5/2010   |
| Transmission and Distribution        | 500-08-009      | 1         | Sacramento Municipal Utility District                                       | SMUD Micro-Grid Demonstration  | \$ 1,586,290        | 6/30/2012  |
| Transmission and Distribution        | 500-98-014      | 250       | New Mexico State University   | Fault Location in Power Distribution System with Penetration of Distributed Energy Resources                                 | \$ 50,000           | 9/30/2009  |

| SB1250 Goal                    | Contract Number | Project # | Provider Name                                      | Project Title   | Project Amount      | Start Date |
|--------------------------------|-----------------|-----------|--|---|---------------------|------------|
| Transmission and Distribution  | KEMA-06-007-P-S | 1         | KEMA, Inc.   | Cyber Security Control System Scoping Study   | \$ 92,105           | 10/31/2009 |
| Transmission and Distribution  | UC MR-076       | 1         | Pacific Northwest National Laboratory              | Extreme Event Research  | \$ 1,160,000        | 3/31/2011  |
|                                |                 |           |  |   |                     |            |
| <b>Climate / Environmental</b> |                 | <b>24</b> |  |   | <b>\$ 7,771,109</b> |            |
| Climate/ Environmental         | 500-07-014      | 1         | Scripps Institution of Oceanography - UC San Diego | California AUV Air Pollution Profiling Study  | \$ 698,991          | 12/1/2009  |
| Climate/ Environmental         | 500-07-017      | 1         | Scripps Institution of Oceanography - UC San Diego | Climate Monitoring, Modeling, and Analyses: Phase III and 2008 Scenarios Impact and Adaptation Study                              | \$ 2,289,016        | 11/13/2009 |
| Climate/ Environmental         | 500-07-042      | 1         | Scripps Institution of Oceanography - UC San Diego | Development of Probabilistic Climate Projections for California   | \$ 1,200,000        | 12/17/2009 |
| Climate/ Environmental         | 500-07-043      | 1         | Lawrence Berkeley National Laboratory              | Greenhouse Gas Abatement and Climate Change Impact Adaptation in California: Advanced Methods and Applied Research                | \$ 504,000          | 5/31/2010  |
| Climate/ Environmental         | 500-07-045      | 1         | UC Davis   | Particulate Matter Characterization in Airmass Transport  | \$ 120,000          | 9/30/2010  |
| Climate/ Environmental         | 500-08-005      | 1         | UC Davis   | Modeling Integrated Adaptation to Climate Change for Californias Water Supply and Hydropower Systems                              | \$ 300,000          | 6/10/2011  |
| Climate/ Environmental         | 500-08-007      | 1         | Altostratus, Inc.                                  | MultiEpisodic and Seasonal Impacts of and Emissions Credits from Heat Island Mitigation Strategies                                | \$ 200,000          | 6/10/2011  |
| Climate/ Environmental         | 500-08-013      | 1         | Pacific Northwest National Laboratory              | Integrated Climate Technology Analysis for California   | \$ 228,337          | 4/30/2011  |
| Climate/ Environmental         | 500-08-018      | 1         | UC Davis Center for Watershed Sciences             | Research on Hydropower Effects on an Amphibian Species of Special Concern   | \$ 285,650          | 3/1/2011   |
| Climate/ Environmental         | BOA-99-189-P    | 1         | UC Irvine  | Laboratory Validation of Novel Greenhouse Gas Monitoring Techniques   | \$ 81,670           | 2/11/2009  |
| Climate/ Environmental         | ICF-06-021-P-R  | 1         | ICF Resources, LLC                                 | UPDATING THE 2003 PIER CLIMATE CHANGE RESEARCH PLAN   | \$ 124,705          | 6/30/2009  |
| Climate/ Environmental         | ICF-06-027-P-R  | 1         | ICF Resources, LLC                                 | Economic Analyses of Sectoral Impacts of Climate Change   | \$ 78,532           | 3/31/2009  |
| Climate/ Environmental         | ICF-06-030-P-S  | 1         | Mark Wilson  | Technical Editors for Annual Report and PIER Environmental Area   | \$ 162,414          | 9/30/2009  |
| Climate/ Environmental         | MRA-02-079      | 1         | Lawrence Berkeley National Laboratory              | California Energy Balances Phase II   | \$ 250,000          | 2/28/2011  |
| Climate/ Environmental         | PIR-08-004      | 1         | UC Davis   | N2O Emissions from the Application of Fertilizers in Agricultural Soils   | \$ 499,960          | 12/30/2011 |
| Climate/ Environmental         | PIR-08-005      | 1         | UC Irvine  | Reductions in urban outdoor water use as an adaptation to rising temperatures and declining water supplies in Southern California | \$ 199,737          | 12/31/2010 |

| SB1250 Goal                   | Contract Number | Project # | Provider Name   | Project Title  | Project Amount    | Start Date |
|-------------------------------|-----------------|-----------|---|--|-------------------|------------|
| Climate/ Environmental        | SAIC-06-030-P-R | 1         | Science Applications International Corporation (SAIC)                       | Climate Change RD&D Target Identification  | \$ 191,360        | 10/31/2009 |
| Climate/ Environmental        | SAIC-06-031-P-R | 1         | Science Applications International Corporation (SAIC)                       | RD&D Support for Climate Change Adaptation   | \$ 53,762         | 10/31/2009 |
| Climate/ Environmental        | SAIC-06-032-P-R | 1         | Science Applications International Corporation (SAIC)                       | Planning Meeting Support for the 2009/10 CalWater Energy, Water and Regional Climate | \$ 11,788         | 1/31/2009  |
| Climate/ Environmental        | SAIC-06-033-P-R | 1         | Science Applications International Corporation (SAIC)                       | 5th Annual California Climate Change Conference                                      | \$ 84,799         | 3/31/2009  |
| Climate/ Environmental        | SAIC-06-034-P-S | 1         | Science Applications International Corporation (SAIC)                       | Support for the 5th California Climate Change Conference                             | \$ 23,369         | 10/31/2008 |
| Climate/ Environmental        | SAIC-06-035-P-R | 1         | Science Applications International Corporation (SAIC)                       | Climate Adaptation Planning in California using Google Earth/weADAPT: a Pilot Study  | \$ 140,099        | 7/31/2009  |
| Climate/ Environmental        | SAIC-06-036-P-R | 1         | Science Applications International Corporation (SAIC)                       | Preparation of a high-level research plan for California Climate Action Team Report  | \$ 31,840         | 11/30/2008 |
| Climate/ Environmental        | SAIC-06-037-P-R | 1         | Science Applications International Corporation (SAIC)                       | 5th Climate Change Conference Speakers   | \$ 11,080         | 10/31/2008 |
|                               |                 |           |   |  |                   |            |
| <b>Program Administration</b> |                 | <b>14</b> |   |  | <b>\$ 827,902</b> |            |
| Program Administration        | ICF-06-023-P-S  | 1         | Nexant, Inc.  | Technical Reviewers for Wind Storage Solicitation 2007                               | \$ 19,990         | 3/31/2008  |
| Program Administration        | ICF-06-028-P-R  | 1         | ICF Resources, LLC  | Task 1 - Contract Administration and Management                                      | \$ 29,760         | 10/31/2009 |
| Program Administration        | ICF-06-029-P-S  | 1         | ICF Resources, LLC  | Task 1 - Contract Administration and Management                                      | \$ 48,000         | 10/31/2009 |
| Program Administration        | KEMA-06-013-P-R | 1         | KEMA, Inc.  | Cost Benefit Review of PIER program  | \$ 541,969        | 10/31/2008 |
| Program Administration        | KEMA-06-014-P-S | 1         | KEMA, Inc.  | New baseline requirements for the Project Information Management System              | \$ 11,543         | 10/31/2008 |
| Program Administration        | KEMA-06-015-P-R | 1         | KEMA, Inc.  | Task 1 - Contract Administration and Management                                      | \$ 62,880         | 10/31/2009 |
| Program Administration        | KEMA-06-016-P-S | 1         | KEMA, Inc.  | Task 1 - Contract Administration and Management                                      | \$ 48,000         | 10/31/2009 |
| Program Administration        | KEMA-06-017-N-S | 1         | KEMA, Inc.  | Task 1 - Contract Administration and Management                                      | \$ 12,000         | 10/31/2009 |
| Program Administration        | MRB-08-001      | 1         | The Regents of the University of California, Office of the President - CIEE | UC Research Agreement Administration   | \$ -              | 8/31/2011  |
| Program Administration        | NCI-06-023-P-S  | 1         | Navigant Consulting, Inc.   | Task 1 - Contract Administration and Management                                      | \$ 29,280         | 10/31/2009 |
| Program Administration        | NCI-06-024-N-S  | 1         | Navigant Consulting, Inc.   | Task 1 - Contract Administration and Management                                      | \$ 6,000          | 10/31/2009 |
| Program Administration        | SAIC-06-038-P-S | 1         | Science Applications International Corporation (SAIC)                       | Task 1 - Contract Administration and Management                                      | \$ 8,880          | 10/31/2009 |
| Program Administration        | SAIC-06-039-N-S | 1         | Science Applications International Corporation (SAIC)                       | Task 1 - Contract Administration and Management                                      | \$ 6,000          | 10/31/2009 |

| <b>SB1250 Goal</b>     | <b>Contract Number</b> | <b>Project #</b> | <b>Provider Name</b>                                  | <b>Project Title</b>                            | <b>Project Amount</b> | <b>Start Date</b> |
|------------------------|------------------------|------------------|---|---|-----------------------|-------------------|
| Program Administration | SAIC-06-040-G-S        | 1                | Science Applications International Corporation (SAIC) | Task 1 - Contract Administration and Management | \$ 3,600              | 10/31/2009        |